ANNUAL WATERWORKS NUMBER

Engineering News-Record

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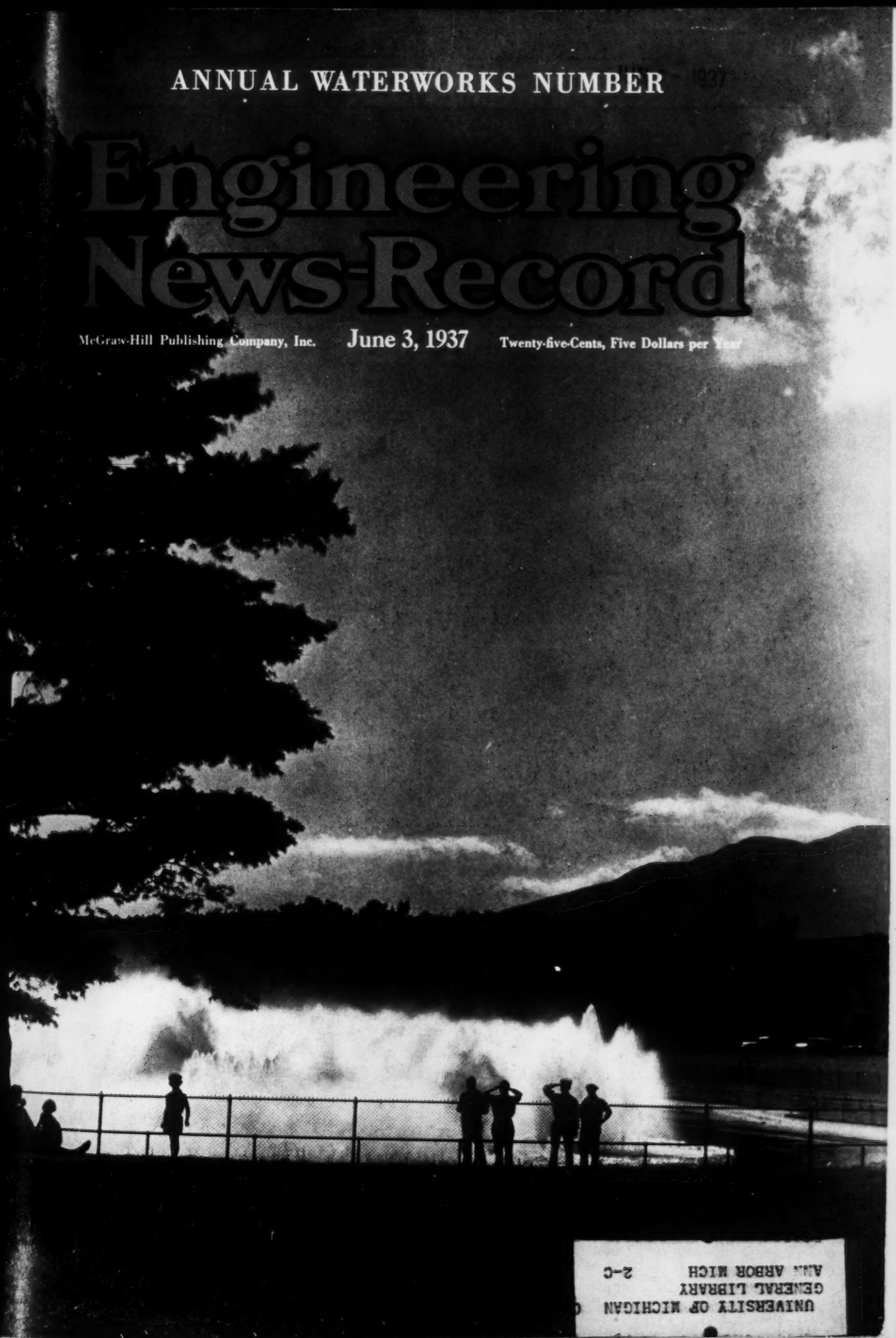

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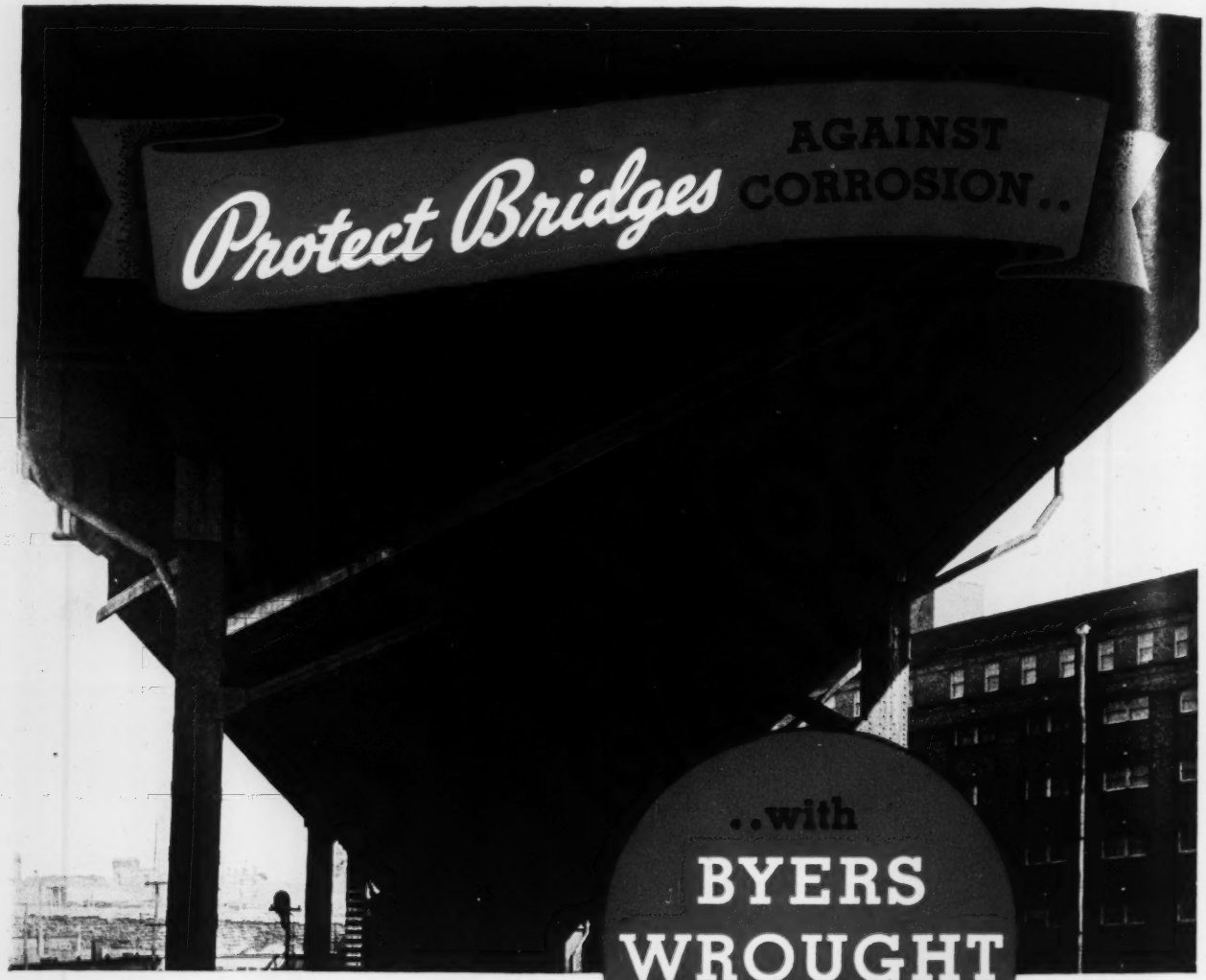

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An Old Friend in *New Dress*

LEST any of our long-time friends be unduly startled when *Engineering News-Record* next calls on them, this is to warn them that hereafter they may expect their weekly visitor to appear in a new costume.

Every magazine, like every man, develops a personality; of that personality one element is its dress. Appropriate dress, whether for a man or a magazine, will conform to certain canons of style. It should, for example, be in the mode; that is, it should conform to the prevailing taste of those whose acceptance it seeks. Then, too, it must fit its subject neatly and be quite in harmony with the other elements that enter into personality. By whatever other standards we may judge dress, these two are essential.

During its sixty-three years of continuous service *Engineering News-Record* has sought consistently to develop and maintain a personality that would win the interest and deserve the respect of civil engineers and construction men the world over.

In its statements of fact and opinion, it has striven for accuracy and authority. In its estimate of trends, it has sought to cultivate vision. In the scope of its content, it has watched alertly to maintain a sound balance. In its judgments it has taken counsel of reason and fairness. In its reporting of current events it has spared no pains to achieve promptness and timeliness. In its appraisal of those various and complex outside forces that affect the welfare of those it would serve, it has tried to maintain poise and sanity.

ALL these are matters of substance. They constitute the character of the man or the magazine; they are, after all, the reality beneath the outward appearance.

But with respect to appearance also, *Engineering News-Record* has sought always to be worthy of its character and mission. It has kept constantly in mind the requirements of easy reading, attractive makeup, effective arrangement and dignified presentation. In its dress it has sought to reflect the distinctive qualities of its content, mindful always that "th'apparel oft proclaims the man."

But however consistently an editorial staff may adapt its product to the minor shifts in current taste, there come times when changing standards and requirements of readership demand more comprehensive revision than can be achieved from week to week or month to month.

Today we are living through such a time. So, during recent months, the editors of *Engineering News-Record* have been reviewing critically the content and style of this journal. The fruits of their study and effort will appear in the next issue.

Needless to say, the new dress implies no sacrifice of those essential qualities described in the foregoing. As always, it is our objective to offer the engineering and construction field a weekly journal, second to none in vision, sanity, scope, accuracy, authority and timeliness. Constant improvement on all these counts remains the major concern of the entire staff.

IT it our purpose to clothe such a service in keeping with the highest standards of presentation. To achieve that purpose the staff has gone outside its own ranks for qualified help; to its own understanding of its readers' needs it has joined the specialized skill of eminent counsel who has left his mark on the magazine journalism of our time. In its new form *Engineering News-Record* will represent the best engineering and construction paper we know how to write presented in the most acceptable style that modern journalism can make available. Confident that this combination will enhance that service to the reader which must remain our primary objective, the staff of *Engineering News-Record* hopes that its new dress will commend itself to its many friends in every department of engineering and construction.

Willard Chevalier

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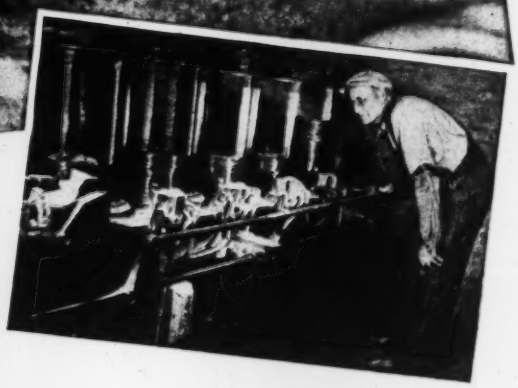

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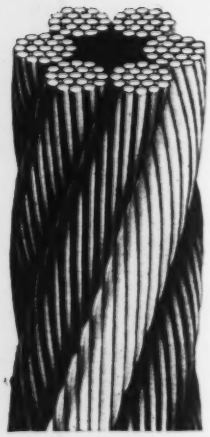

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JUNE 3, 1937

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The Cover **this week shows the aerator below Olive Bridge Dam at Ashokan Reservoir of the Catskill water supply system, New York. The aerator has 1,600 nozzles and is capable of handling all the water that passes into the aqueduct**

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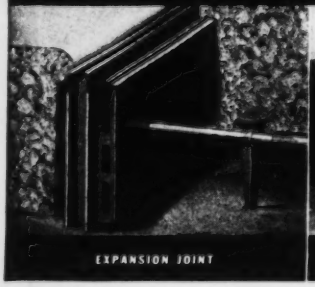

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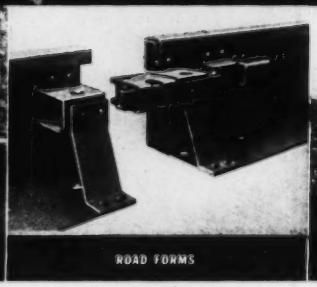

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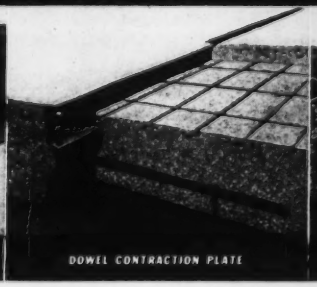


DOWEL CONTRACTION PLATE

TRANSVERSE CONTRACTION PLATE

ENGINEERING NEWS-RECORD

ANNUAL WATERWORKS NUMBER

June 3, 1937

An issue devoted to water system improvement outlined in eleven articles dealing with essential elements of waterworks operation, maintenance and management

Better Water Treatment

PAUL HANSEN

Greeley & Hansen, Consulting Engineers, Chicago

SCIENTIFIC ADVANCES in practice and special equipment now available make it possible to achieve more effective purification plant performance

FOR a number of years processes have been available for effective and economical purification of water. Recent improvement trends are in the direction of refinement in practice rather than in the introduction of new processes. The depression stimulated ingenuity and in the general progress of scientific advancement water treatment was not neglected. The infiltration of well-trained personnel into the field of operation as well as that of equipment manufacturer has been followed by productive achievements resulting from competent research. Increasing demands of the times have brought many of these newly-discovered improvements to maturity. In consequence, these technical advances have made available a better understanding of purification processes as well as improved facilities for the removal of bacteria, turbidity, taste and odor, hardness, iron and manganese and corrosive agencies. Laboratory methods have been extended to operation control; mechanical and electrical equipment has been adapted to new uses. The newer facilities born in the depression period and now maturing into usefulness are set forth in this article.

Preliminary treatment of water prior to filtration has been given extensive study for a number of years but it still constitutes an elusive aspect of water purification. Progress has been made in improved flocculation by means of gentle and prolonged agitation, but not all plants report complete success or marked improved economy as a result of such mixing. It is obvious to those familiar with water purification practice that there is still much to be learned concerning effective and economical coagulation.

Some emphasis has been placed during the past year on coagulating chemicals. Alum is still the most generally used. Developments in chemical coagulation of sewage with ferric chloride have attracted renewed attention to iron compounds. Probably the next few years will show more interest in the use of ferric chloride and ferric sulphate, which are now available commercially at relatively low prices. The decreased cost of chlorine, especially when purchased in tank cars, may stimulate interest in chlorinated copperas. The use of copperas in conjunction with lime is being revived because of its adaptability in removing manganese. One of the most promising innovations in coagulation is the use of sodium silicate in conjunction with aluminum sulphate as proposed by John R. Baylis of Chicago. Experimental evidence indicates a pronounced improvement in flocculation. The technique involves the use of acid to neutralize the sodium silicate.

Improvement in coagulation has been sought in more complete solution of the coagulant. It has been observed by operators that standard commercial feed devices do not effect a complete solution of the coagulant and this applies more particularly to alum. More complete solution has been accomplished by using larger dissolving boxes in connection with dry-feed machines and providing mechanical agitators that produce a thorough and turbulent mixing of the chemical in the dissolving water.

Operators are giving attention to feed machines that weigh the chemicals and several such machines are now on the market at reasonable cost. A. F. Mellen, Minneapolis, has been an early experimenter along this line. By the use of such machines a uniform weighed amount of the chemical is applied to the water rather than a uniform volumetric amount. This results in both economy and more exact chemical application.

FIG. 1—OPERATING FLOOR *of the Hammond (Ind.) 20 m.g.d. filtration plant. Filters and controls are located on one side of the building (right) and mixing chambers on the other.*

In applying chemicals for coagulation, carbon for odor control and lime either for assisting coagulation, softening or correction of corrosion, emphasis is given to placing the chemical feed machines as close to the point of application as possible to reduce the length of pipes and hose, which in long runs give trouble by clogging as a result of air binding. In this connection the introduction of a raw water flume passing through the chemical feed room is of advantage, as exemplified by the new plant at Hammond, Ind. At Moline, Ill., application of lime for correction of corrosion of filtered water has been conveniently arranged in the pipe gallery which is relatively spacious.

At large water purification plants, especially those located on lakes and small streams the problem of sludge disposal is sometimes difficult. At a number of softening plants lime sludge is dried in lagoons and sold for soil conditioning. At the Chicago experimental station investigations are now being made to determine the feasibility of dewatering sludges with vacuum filters.

Filter washing improvements

The most pronounced trend with reference to filter washing is the application of surface wash in addition to the usual upward flow wash admitted into the underdrain system. The surface wash is not a new idea; it was first developed experimentally at Oakland, Calif., in 1907, by W. W. DeBerard and Langdon Pearse. Within the past few years it has been revived by John R. Baylis in connection with studies on the purification of the Chicago water supply. Within recent years filter plants at Winnetka, Milwaukee, Hammond, Racine, Kenosha, Covington, Charleston and Grand Island, N. Y., have been equipped with surface wash. The plant at Hammond has been designed to permit the later introduction of surface wash with minimum expense.

At Kenilworth, Ill., there has been introduced additional filtered water collectors within the sand bed. These are conical screens which extend from 1 to 2 ft. below the sand. The washwater is admitted through these screens in a reverse direction and has been found highly effective in maintaining the sand in clean condition. In other words, it acts as a surface wash. Increased filter capacity is obtained at Kenilworth at relatively small expense but the success is in part due to the good quality of the raw water used at this plant. Experiments at Toledo where the raw water is exceptionally difficult to handle, have not shown such marked success.

The theory upon which surface wash is predicated is that mud-ball troubles result from the breaking up of the surface mat of dirt and coagulant into large flakes; these roll up to form mud balls as a result of the action of the washwater admitted from underneath and then sink within the sandbed. The surface wash breaks up the surface mat into minute pieces before the underneath wash is applied and these tiny pieces are readily carried out by the upward current of the underneath wash. In addition, the surface wash seems to exercise a scouring action on the sand that is not obtained so effectively by the underneath wash alone. On the other hand, with high rates of washwater from underneath, the scouring action seems to keep the sand in clean condition as exemplified by experience at Detroit and Cleveland.

Sand grain size

There is a tendency to use larger sand grains in filters than formerly. A number of factors are apparently responsible for this. The almost universal practice of chlorinating water in conjunction with filtration relieves the sandbed of some of the burden of obtaining bacteria removal. The larger sand grains permit longer filter runs and also permit higher rates of filtration when required by peak demand. Improved understanding of coagulation and generally better flocculation permits the use of coarser sand grains without passage of minute particles of coagulant through the filters. The tendency to use higher rates of washwater favors the use of a coarse sand in that higher rates of washwater (and hence better scouring effect) can be obtained without excessive expansion of the bed and loss of sand.

At Springfield, Ill., Charles H. Spaulding used sand which grew in size through calcium carbonate incrustation, at increasing rates of filtration until the sand grains reached an effective size of 1 mm. and the rate of filtration became 4 gal. per sq.ft. per min. This experience was regarded as so satisfactory that the

new purification works, recently placed in operation, were designed to operate at the above high rate and the encrusted and enlarged sand was transferred from the old plant to the new one. At the new plant washwater is applied at an upward velocity of 42 in. per min. with an expansion of the sand bed of but 14 per cent. Before applying washwater the surface of the sand is vigorously hosed to break up the surface mat. Washwater overflow troughs are omitted without apparent detriment.

Filter underdrains

Revived consideration is being given to porous material for filter underdrains. A porous layer was first attempted by the late William Gore at the filter plant at Windsor, Ont. This layer was formed simply by mixing a small quantity of cement with gravel to form in effect a lean porous concrete. Later W. G. Kirchoffer used a similar arrangement at Wausau, Wis. It was rather difficult by this relatively crude method to obtain a uniform and proper porosity. More recently porous plates have been produced commercially. They are similar but of coarser texture to those used in diffusing air in connection with the treatment of sewage by the activated-sludge process. Such plates have recently been installed in some of the old filters at Denver, Colo. and O. J. Ripple, superintendent of filtration, tentatively reports favorable results. The advantages claimed for porous plates are: (1) that the gravel layer required in connection with the conventional underdrain systems may be omitted; and (2) corrosion is eliminated. It remains to be seen whether these plates clog seriously. If the turbidity is effectively removed at the surface of the filters it is assumed that the tendency to clog will be slight. If clogging should occur it is still argued that the sand can be removed much more readily and replaced in the absence of the gravel layer and that the porous plate may be cleaned with a caustic solution.

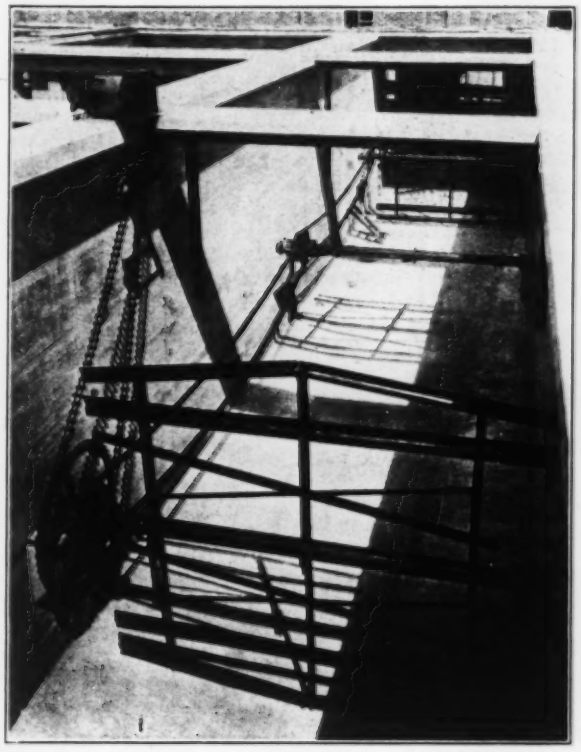


FIG. 3—STIRRERS *in the reaction basin of the Michigan City water filtration plant.*

There is growing realization that storage for filtered water is an important part of a water purification plant. Theoretically, the desirable combination of filter capacity and filtered water storage volume is that which will result in minimum cost. When speaking of filter capacity it is important to recognize that the filtration process comprises preliminary treatment as well as filtration and that this preliminary treatment should be adequate for any rate of filtration. Often when the demand on a filter plant is greatest raw water is at its worst and good preliminary treatment is essential. When these factors are taken into consideration the economical balance requires storage sufficient to neutralize the differential between a uniform rate of filtration and a variable rate of consumption during a day of maximum consumption. More storage than this is often desirable. Where topographical conditions permit as much of the filtered water storage as practicable should be placed at an elevation where it becomes instantly available without the necessity of throwing into service additional pumps; but even where the topography is flat it is desirable to have a substantial portion of the filtered water storage in elevated tanks. During the recent flood in the Ohio River Valley the importance of large elevated storage was emphasized as purification works were forced out of commission through inundation.

Sanitary safety of the water supply is now taken as a matter of course and no compromise is permitted on this score. More and more emphasis is being placed upon physical characteristics, more particularly taste and

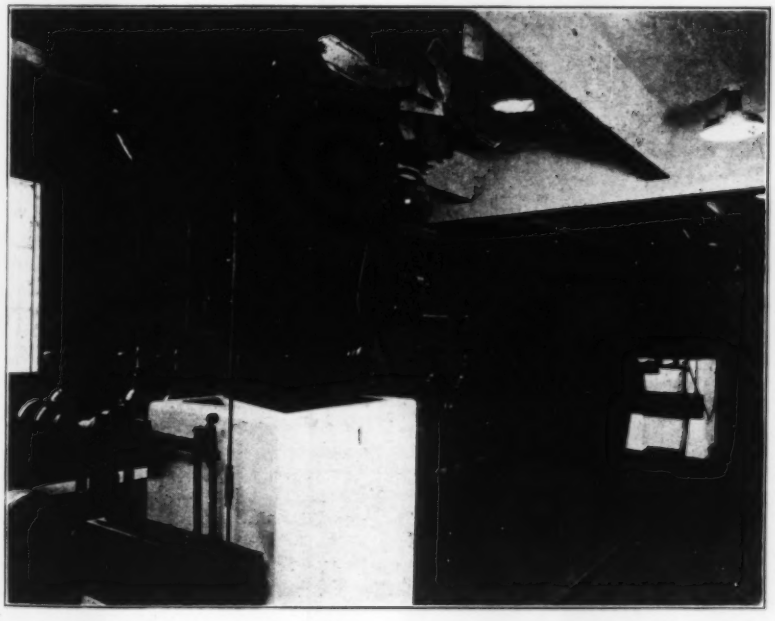


FIG. 2—CHEMICAL FEED ROOM *in the Hammond plant, through which the open raw water flume is carried (back of feeders). This permits short piping and easy change in point of chemical application.*

odor. This is not a new development but is being emphasized more and more. Introduction of the osmoscope into most well-equipped waterworks laboratories during the past year has increased the accuracy of observing and recording odors and this in turn has stimulated better control.

The ease with which powdered activated carbon can be applied at existing filter plants has resulted in almost universal use of this substance rather

FIG. 4—SEDIMENTATION AND MIXING BASINS *combined for improved lime treatment at Springfield, Ill. Raw water and lime are introduced at the top of the cone-shaped hood which contains a stirrer; the water then rises up through an annular V-shaped compartment to be skimmed off at the periphery of the outer cone.*

than the earlier developed method of running filtered water through beds of granulated activated carbon. The additional initial cost also militates against the installation of granulated carbon units. However, their effectiveness seems to be distinctly greater than powdered activated carbon and more recently such units have been installed at Oshkosh, Wis., and at Culver City, Calif. Monroe, Mich., has a unit of granulated carbon that has been in operation for three years.

When activated carbon was first brought into extensive use there was a general assumption that it had to be applied in small quantities only—generally not exceeding 25 lb. per m.g. Now, operators do not hesitate to put in as much as 150 lb. per m.g. if necessary for the elimination of taste and odor.

Water softening has made some progress. The popular mind seems to be more interested in household water softeners than in municipal water softening plants. No doubt this has been due to the activity of companies manufacturing water softening installations of the zeolite type. The lime-and-soda process of water softening is still the predominant one used for municipal purposes and generally shows superior economy over zeolite softening unless the hardness is due predominantly to non-carbonates.

Interesting results have been obtained in accelerating and improving lime treatment by Charles Spaulding at the new Springfield plant. The lime is introduced into the raw water and maintained in active agitation to insure complete reaction for a period of 30 min. The treated water is admitted into a sedimentation basin or compartment at the bottom in such manner as to cause the water to rise upward through a cloud of precipitated calcium carbonate. This cloud seems to be effective in promoting precipitation and clarification. The settled water is drawn off at the surface. Mr. Spaulding's arrangement comprises an inside truncated cone with the small end at the top. The raw water is admitted to the top of this cone. Inside the cone is a stirring mechanism, one feature of which comprises long arms near the bottom. Outside of this cone is another truncated cone with the large end at the top. The annular V-shaped compartment thus formed by the inner and outer cones constitutes the sedimentation compartment. Between the periphery of the lower part of the interior cone and the lower part of the exterior cone is a slot through which the treated water rises more or less vertically. The sludge cloud forms immediately above this slot and its formation and maintenance is essential to good results.

Iron and manganese removal

De-ferrization and de-manganization of water has been advanced through better understanding of the chemistry of these processes. The work of Dr. F. E. Hale of New York in removing iron from well water without aeration is especially notable.

Where water softening is employed the process of removing manganese is simplified because the high pH value developed in connection with lime treatment is conducive to its precipitation and removal. In the removal of manganese where softening is not required the future will probably bring about a greater consideration of the use of pyrolusite, a manganese ore which acts more or less as a catalytic agent. This process has been used at Brainerd, Minn., with considerable success but its use has not been extended elsewhere. It is not new in principle as it has been recorded in literature as early as 1912, and in 1914 experiments on the use of manganic oxide were conducted by the Illinois State Water Survey at Peoria, Ill.

Through the years the process of filtration has attained more and more dignity as exemplified by the generally high grade personnel in charge of water purification works and the willingness of officials to spend large sums of money for adequate and architecturally beautiful housing.

Pollution Control Commission Appointed in Ohio

GOVERNOR DAVEY of Ohio has signed a bill providing for the appointment of a commission of five members, who will serve without pay, to meet with similar commissions from the states of New York, Pennsylvania, West Virginia, Indiana, Illinois, Kentucky and Tennessee to form an Ohio valley stream pollution compact based upon a tentative draft which was formulated by a commission from these states several months ago.

The states of New York and West Virginia have already set up similar commissions by legislative enactment. Similar legislation has been introduced or will be introduced in Tennessee, Kentucky and Illinois. Indiana and Pennsylvania, it is understood, hold that under existing statutes in those states no additional authority is necessary to set up a commission.

The term of the Ohio commissioners will be four years. When all the states have appointed their commissioners, a meeting will be called to consider abatement and control of stream pollution in the Ohio Valley.

Selecting Pumping Equipment

CHARLES B. BURDICK
Alvord, Burdick and Howson, Consulting Engineers, Chicago

RELIABILITY, economy of operation, and adaptability to specific requirements are the factors which govern the selection of water pumping equipment

SELECTION of pumping equipment is a highly technical business transaction and should be treated as such if costly mistakes are to be avoided. The following discussion of general principles of selection, while applying to the purchase of pumps for all purposes, relates particularly to pumps for municipal water supply. This is a type of service involving assured continuity of need—reliability in such service is a prime essential. It is a catastrophe for a city waterworks to shut down and the effects are so far-reaching that it must be avoided at all costs. And it is not uncommon to expect a waterworks pump to operate continuously without interruption for a year at a time. Economical operation, therefore, while secondary is highly important if water is to be served at least cost.

Pump selection should also be based on the theory that the equipment best-suited for a particular job is the machine that will furnish the required service at the least annual cost; the latter should include interest and depreciation upon the investment, plus expenses of operation and the cost of suitable housing.

Pumps for every job

The waterworks field is sufficiently broad to find adaptation of practically every type of pumping device. It is not overstating the case to say that every type and "make" on the market is best adapted to some particular situation. New devices should be selected with caution, however, bearing in mind the need for reliability and the necessity for new inventions to pass through a development stage to correct unseen defects.

Among the situations requiring special adaptation of pumping equipment may be mentioned the following:

1. High-lift pumping to city distribution systems by direct pressure, in which pumping heads will range from 150 to 200 ft.; the pump must follow the variations in demand at approximately uniform pressure.
2. High-lift service pumping to an elevated reservoir in which the pumping rate may be nearly uniform.
3. Low-lift service as in pumping from source of supply to filters under heads from 35 to 50 ft.
4. Standby service under any of the above circumstances, in which a pump is called upon only for occasional use in case of unusual demand or in case of a breakdown.
5. Deep-well pumping, a service requiring special adaptation to limited well bores and high heads.

These special requirements are also modified by such individual circumstances as the kind and condition of the machinery already installed if the device is to supplement a going plant. Most purchases in these days are for supplemental installations because the cities have long had public water supplies. The magnitude of plant output also has an important bearing upon pump type, since certain kinds of pumps are limited as to economical size. The plant site, in regard to local topography and the possibilities of inundation due to floods, often determines the comparative adaptability of horizontal or vertical type pumps.

Although it is but a step from the steam engine of James Watt to the steam pumping engine, it required a century of development to approximate its present form, and a half century more to perfect it. In the first pumps the engine piston rod was merely extended into a water end where it was attached to a plunger similar to the steam piston. Then with the addition of suction and discharge valves the pump was complete. Nearly all waterworks pumps were designed on this principle up to the turn of the last century. In fact, this was the first adaptation of the steam engine. The new device found its field in the pumping of the wet Cornish mines.

FIG. 1—CONTRASTS *in pumping equipment. In the background a crank-and-flywheel steam engine installed a half century ago rears high above a modern electric two-stage centrifugal unit.*

It was simple, reliable and quite economical.

The public waterworks building era began just after the Civil War and reached its greatest development in the early "eighties." Within 15 to 20 years thereafter nearly all towns in the United States of 5,000 population or more built water supply systems.

The earliest steam pump widely used was the Holly crank-and-flywheel engine made at Lockport, N. Y. lar towns usually installed a gasoline engine direct-connected to triplex power pumps, pumping intermittently to elevated tanks. During this time the crank-and-flywheel pumping engine of several "makes" monopolized the field in the larger places. Designs were progressively improved up to 1910 or shortly thereafter when performance ratings up to 200,000,000 ft.-lb. of work per 1,000 lb. of steam, were attained. The latest and best of these were generally built with three steam expansions. The latest and best of the horizontal machines were cross-compounds of the Snow type. They were slow-moving machines, with low steam consumption and low repair bills. After 30 years of use their ultimate life is yet to be determined. They continue in use (and properly so) where steam is the motive power and where their space is not needed for larger capacity.

Prior to 1895 the centrifugal pump was used chiefly in construction work, or for other uses where large quantities of water were to be moved at low heads, say 15 to 20 ft. with 50 ft. head as the limit. An efficiency of about 50 per cent was attained by the best. These pumps were usually belt-driven.

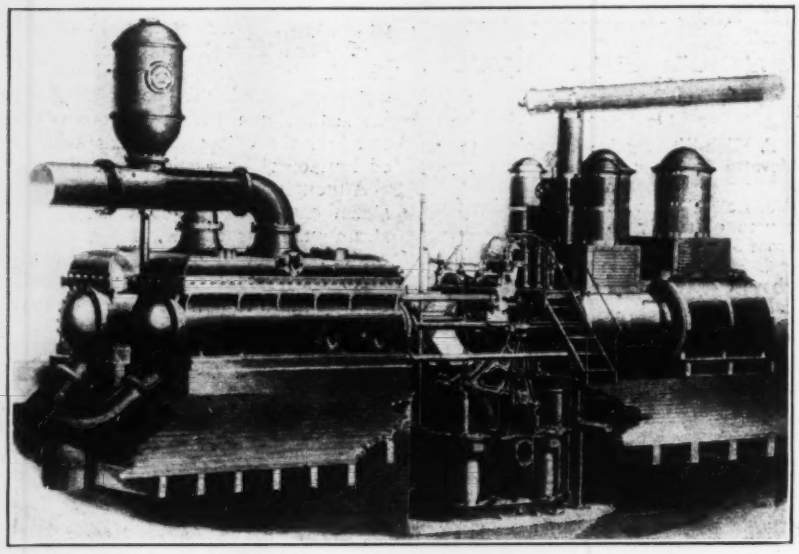


FIG. 5—WORTHINGTON *direct-acting compound duplex steam pumping engine widely used in municipal waterworks during the period 1863–1895. This 6 m.g.d. pump was installed in 1876 at Fall River, Mass.*

The first installations were semi-vertical and were employed in conjunction with elevated reservoirs which balanced variations in water use. Early in the building era Worthington came forward with a horizontal direct-acting pump without a flywheel, usually built duplex; this was adapted to direct pressure pumping without the aid of a balancing reservoir. These two systems, the Holly and Worthington, were backed by enterprising salesmanship which had much to do with their general adoption for the public waterworks use. When the direct-acting type of pump was first introduced it was a subject of hot debate in many a city council. It seemed incredible that it could follow the varying water demand with no human hand to guide it.

Rapid improvement made

Within a short time the Holly engine was also adapted to direct pressure service through the aid of a pressure governor. Other manufacturers of both types soon entered the field. During the "eighties" most towns of 5,000 population or less, installed the direct-acting steam pumps. In the "nineties" new works for simi-

installations are still in use in the larger cities and probably will be used for many years to come, although few new installations have been made since 1925. Weight and cost now make it impossible for them to compete with pumps of the rotative type.

TABLE I— PROGRESSIVE IMPROVEMENT IN OPERATING ECONOMY OF STEAM PUMPING ENGINES

Reciprocating Pumps	Year	Duty Million Ft.-lb.	Remarks
Savery engine, England	1697	5	Steam direct contact with water
Watt's engine "	1769	20	Walking beam, vertical
Later Cornish engines	....	60	
Simpson engines	1848–72	75–90	Compounds, walking beam, verticals—London Water Works and in early American cities.
Holly quadruplex	1860–70	85	Widely used in early American waterworks
Gaskill engine, Saratoga, N. Y.	1884	117	Horizontal compound, widely used
Allis, Milwaukee	1893	154	Vertical triple, 121 lb. steam
Allis, St. Louis	1900	179	" " 126 lb. "
Turbo-Centrifugal Pumps			
De Laval, Chicago	1922	154	175 lb. steam, 150° superheat, 60 m.g.d.
" " "	1924	172	" " " " " "
" " "	1926	182	" " " " " "
" " "	1928	218	300 lb. " 200° " 75

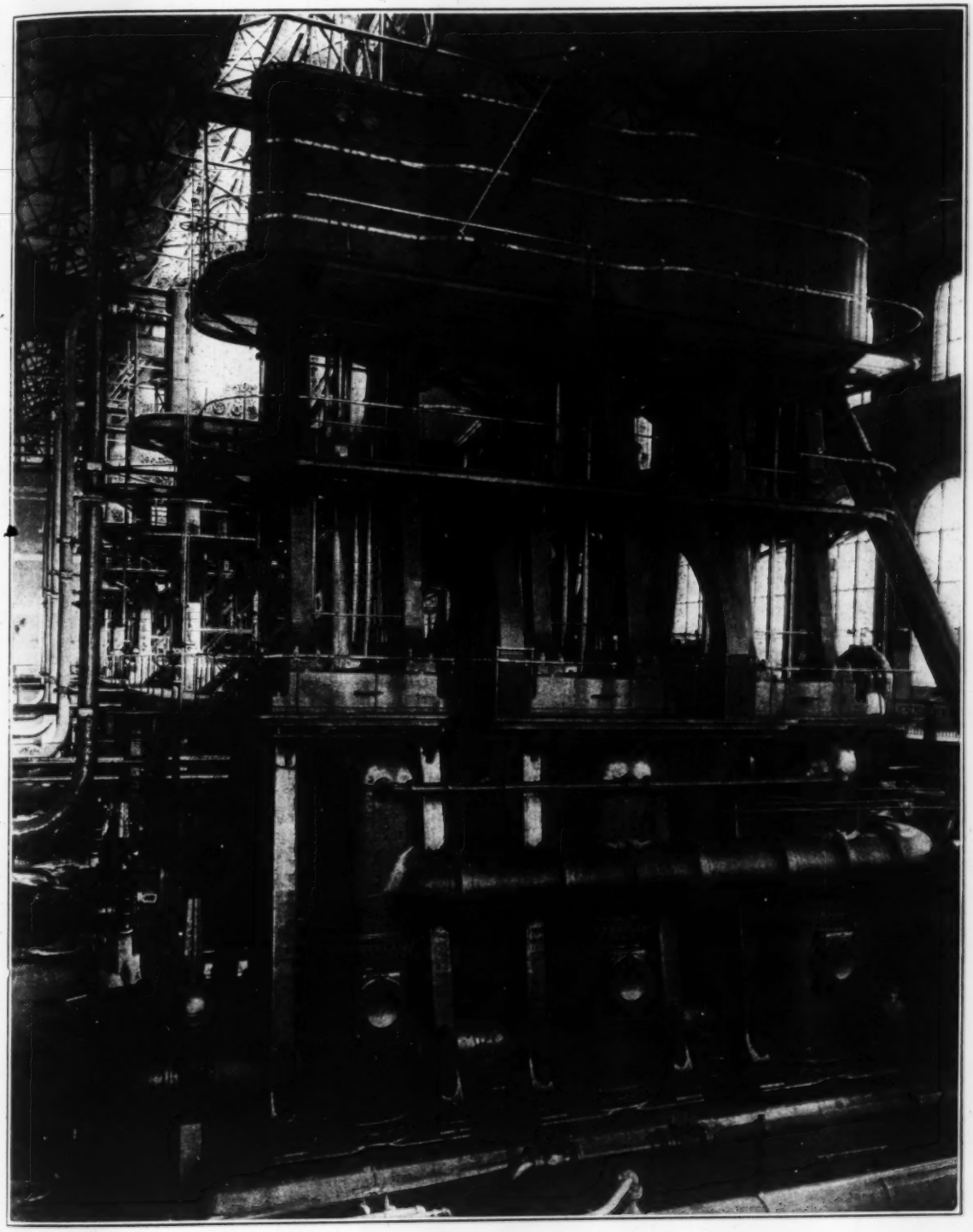
This fine old engine was built both in horizontal and vertical type. The latter type was used in the larger sizes above 20 m.g.d. These machines

Centrifugal pump advances

Improved designs for higher heads were first made in Europe; and European designers in American factories have been responsible largely for the capture of the waterworks pumping field by centrifugal pumps within the last 25 years. The early recognition of the improved types came in the Far West and Byron Jackson, of San Francisco, was the first to manufacture them in this country.

With improved efficiency, greater relative speeds and adaptation to greater heads it was but a step to compounding, that is, connecting pumps in series; thus the multi-stage centrifugal pump was born and came into wide use about 1910. Direct connection to electric motors improved the dependability and efficiency of these pumps and greatly multiplied their usefulness.

Steam turbine developments completed the conquest of the waterworks pumping field for the centrifugal pump. For a few years after it came into use the centrifugal pump was ill-adapted to high heads where steam was the motive power. The steam



Colossus among pumps, the famous Holly engines of a past era are still giving good service. At Buffalo, N. Y., this battery of five 30 m.g.d. triple-expansion units in the Francis G. Ward station has been operating for nearly three decades.

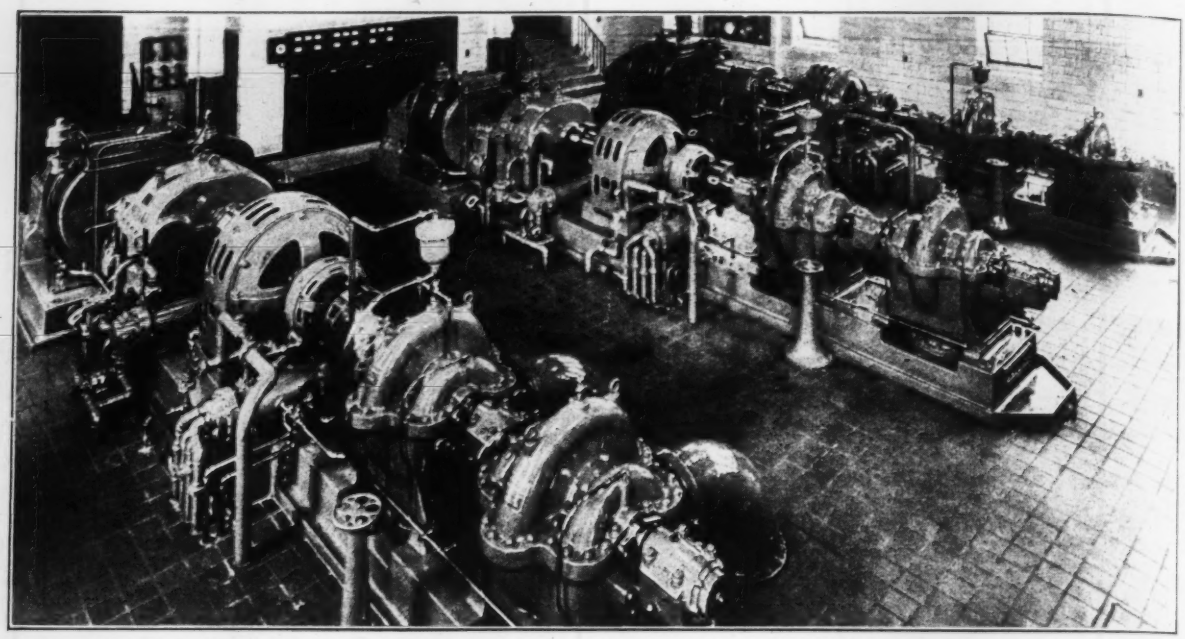


FIG. 3—TURBINE GEARED *centrifugal pumping units at Newton, Mass., with capacities of 8, 6, and 4.25 m.g.d. operating against heads of 352, 305 and 272 ft., respectively. On each unit a 200-kw. generator is connected between the gear reduction box and the pumping units.*

engine is inherently slow and although gearing devices were tried they were soon discarded as noisy, short-lived and unreliable. Then the steam turbine came along. But it, too, was unadaptable because it ran too fast for direct connection to the pump without great sacrifice in steam economy. This difficulty was quickly and effectively solved through the design of helical, rolling, high-speed gears by DeLaval of Sweden and the manufacturer of complete turbo-centrifugal pumping engines in the country. Machines of this type, greatly improved in recent years, have now practically completely captured the large unit waterworks field where steam is the source of power.

This has been accomplished by a steam duty performance equal to the best of reciprocating pumps, an investment cut of 50 per cent or more and a reduction of more than half the required space needed for housing. Reliability has been proved. Durability is not yet fully determined—it promises well after 20 years of use but may not equal the long life of its predecessor. There have been pump impeller troubles by pitting in certain cases that are not generally understood. In the aggregate, however, repair bills have been relatively small.

As illustrative of the advantages of the small space occupied as compared to that required by the reciprocating pump in special situations, a prominent waterworks engineer who had just completed a large and important waterworks station remarked to the writer that if the turbo-centrifugal had come on the market a year earlier, its use would have saved a million dollars in the cost of this station.

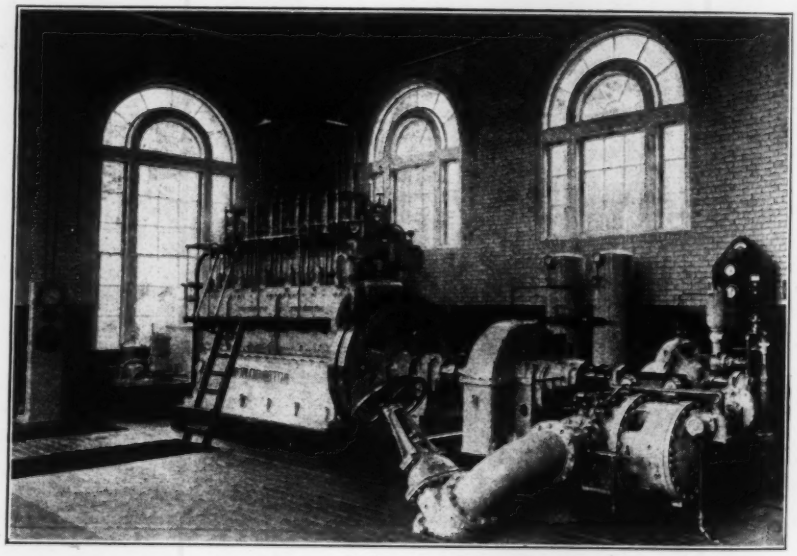


FIG. 4—DIESEL ENGINE DRIVE *connected through a gear box to a pumping unit used for stand-by service.*

The electric drive for waterworks equipment has been making great strides for some years. Where entirely new pumping plants are built electric power has its great advantage in low investment in machinery and housing and in small costs for repairs and labor of attendance. Best economy is obtained where elevated storage is employed. For the larger plants an average electric rate of 7 or 8 mills per kw-hr. is generally needed for successful competition with the best waterworks steam plant. In smaller plants a higher rate can be paid.

Generally, the service is quite reliable. There have been a few power breakdowns that have discouraged electric pumping in the larger cities. Such interruptions of service can be guarded against, however, by the

installation of suitable reserve units using another source of power. In plants of moderate size a gasoline-driven reserve is frequently used. Conservative designers frankly accept this requirement and provide for it in cost comparisons.

The enterprising electric utility manager noting the municipal boiler plant costs and the man-hours of pump attendance is quite likely to urge the advantages of electric drive to displace steam in the city waterworks. However, if the steam equipment is good, with considerable prospective future life, it is difficult to show a great advantage for the introduction of the electric pump. The writer is familiar with one large waterworks in which a special rate of 4 mills flat just about breaks even with former steam costs. This is a case where the plant in question is one of two (the other is a steam plant) in which, although boilers are not carried under steam, they must occasionally be used on suitable notice and a skeleton steam labor organization must be maintained.

Like the case of the man driving over a rough road to whom the other side looks the better, so the man who selects a deep-well pump has been prone to wish he had bought something else. This tendency has been quite as much due to the general lack of reserve wells when an emergency occurs as to deficiencies in the equipment for pumping. A deep-well pump like all waterworks devices must have a reserve for use in emergencies. This is particularly true of deep-well pumps that must operate unseen and with as little attention as possible. The situation in this regard has been much improved in recent years both as regards pumps and the wells in which they are placed.

TABLE II. — BID COMPARISONS SHOW THAT SOMETIMES THE HIGHEST BID ON A PUMP MAY BE THE CHEAPEST.

Bidder	A	B	C	D	E	F	G
Price bid.....	$4,250	$3,290	$4,085	$3,500	$3,760	$3,400	$3,940
Pump efficiency, per cent	85	84	85	84	82	84	81
Overall efficiency, per cent	78.64	76.55	77.3	76.5	75.98	75.6	74.52
Annual Cost							
Power when pumping 730 m.g. per year....	$7,603	$7,810	$7,734	$7,815	$7,869	$7,908	$8,023
Interest and depreciation	425	329	409	350	376	340	394
Total Annual Cost ..	$8,028	$8,139	$8,143	$8,165	$8,245	$8,248	$8,417

In comparisons such as this it is customary to tabulate other characteristics of the equipment where there are differences that affect its usefulness or desirability. If there are differences that affect maintenance costs this should also be considered in the comparisons of annual costs.

Forty years ago the reciprocating deep-well pump was almost universal. It had a good efficiency rating but was small in capacity and subject to accidental breakdown because of the usual tendency to run it too fast. Nevertheless, it was generally the sole reliance of the small town, industry or institution with deep groundwater as the source of supply. Efficiencies of 75 per cent or more were possible. Repair bills were heavy and service interruptions were numerous and of long duration.

The air lift then entered the field. Its efficiency was comparatively low at first but it was widely adopted because it promised to eliminate excessive repair bills. Later it was much improved in efficiency through better proportioning of submergence, air pressure and eductor pipe sizes. Its chief limitation in common with that of other deep-well devices has been the decreasing water levels, which spoil these proportions, requiring changes as radical as the purchase of new compressor equipment. Nevertheless there are and have been some installations which have proved to be highly satisfactory.

About 1900 the centrifugal pump was applied to pumping water from tubular wells. Like other adaptations of centrifugal pumps this came from Europe. A few years later, manufacture and use began on the Pacific Coast, and shortly thereafter in the Middle West. Within the last ten years successful pumps have been perfected by several manufacturers and their use bids fair to capture the field for pumping tubular wells under lifts up to 500 ft. or more with efficiencies that compare favorably with any centrifugal pumps of equal size.

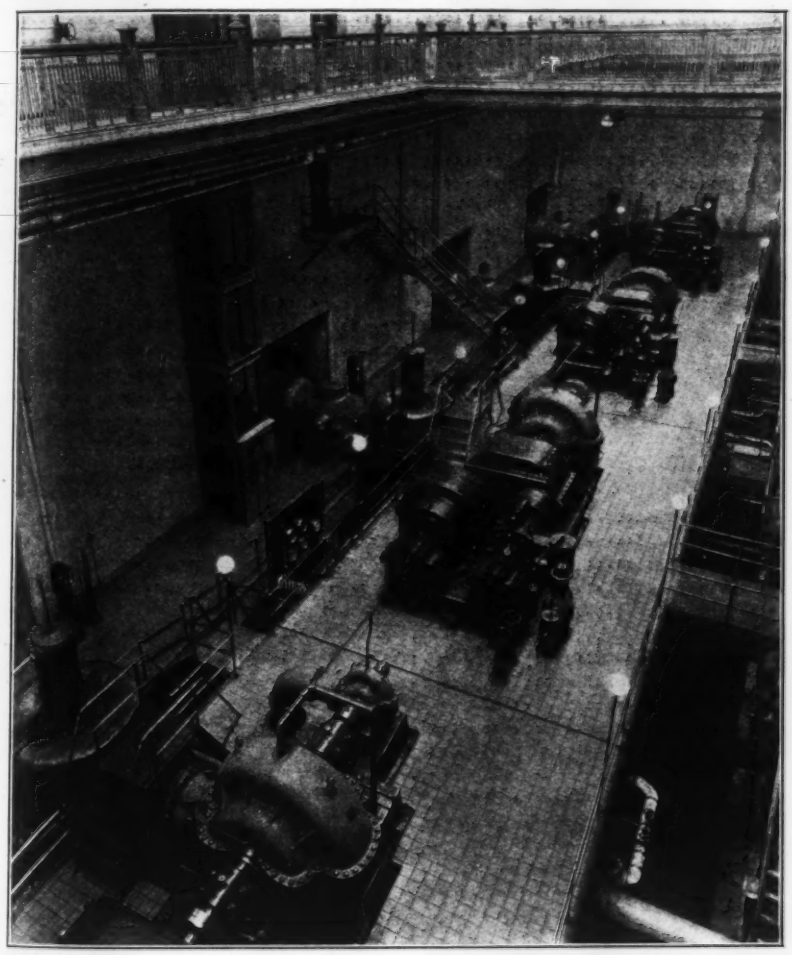


FIG. 4—CENTRIFUGAL PUMP UNITS *at the Chicago Western Avenue station, each with a capacity of 75 m.g.d. They are driven through gear reducers by compound turbines operating on 300 lbs. pressure.*

Nearly all these pumps are electrically-driven by direct connection. A vertical steam turbine with a helical gear connection recently has been adapted to this service. Dependable pumps are now made, capable of continuous use without removal from the well for as long as 2-yr. periods. Capacities of 1,000 gal. per min. or more are common. Such amounts are drawn from bores as small as 12 in. and heads up to 200 or 300 ft. Greater capacities and heads are possible through the use of pumps and wells of greater diameter.

It often happens that a pump is displaced for regular service before it is worn out because a machine of higher efficiency comes on the market. In such a case the old machine may be useful for reserve purposes. For safety in a waterworks it should be possible to handle the peak load with the largest unit "out." To meet this requirement old pumps, kept in repair, serve a useful purpose and should be retained until space occupied becomes too valuable.

The internal combustion engine using gasoline as fuel, although no longer economical for regular use, is well adapted for reserve in plants of moderate size. New installations of this type, making use of multi-cylinder high-speed engines direct-connected to centrifugal pumps, are frequently made. They are practicable in plants of moderate size as a reserve for electric drives. The diesel engine burning low grade oil has recently been improved to the point where it is a practicable machine for everyday use. It is a promising newcomer in the pumping field.

Specifying and buying

It is in the interests of the purchaser to utilize the design skill of the manufacturer. This can best be done by limiting specifications to the results required, thus giving the maker the widest latitude possible in design so far as consistent with local requirements, and the placing of manufactures as nearly as possible upon the same basis of bidding. The bidder should be required to guarantee mechanical efficiency, and the equipment should be tested upon installation to determine compliance with guarantees. One instance is recalled in which a steam turbine upon test after installation revealed the fact that the wrong steam nozzles had been installed through an error in the factory. The importance of efficiency is emphasized by the fact that in the case of an electric centrifugal the value of power used in a year often exceeds the cost of the pump and motor. Strange as it may seem, the highest bid price is sometimes the most favorable bid. The bid analysis (Table II) illustrates this point.

The experience with many recent pump installations indicates that with proper selection of equipment adapted to the service requirements, a long and useful life may be expected. To be successful the modern waterworks must furnish good water at least cost. Well-selected pumping equipment is a large contributor to this success.

Historic Louisville Pumping Station Renovated

AFTER a long period of abandonment and neglect, the historic water pumping station No. 1 at Louisville, Ky., has been restored to its original architectural beauty and put to useful service as a storage building. This landmark of the city was erected in 1856 and for more than half a century housed the original equipment of the Louisville Water Co. The building was designed by Theodore R. Scowden, first chief engineer of the company, assisted by Charles Hermany who succeeded him in that capacity in 1861. The beauty of the classic Corinthian design was emphasized by the white limestone columns and trim.

The initial plant of the Louisville Water Co., which was incorporated in 1854, consisted of the river pumping station, a reservoir located on a high point in the city, and 26 miles of distribution mains. Pumping equipment consisted of two Cornish engines, with a combined capacity of 12 m.g.d. The system, costing about $830,000, was one of the finest in the country at that early date.

In 1893 a second river pumping station, with a capacity of 16 m.g.d., was placed in operation. Since that time there have been many extensive additions and improvements made in the water system, including the construction of a filter plant which has been in operation since 1908.

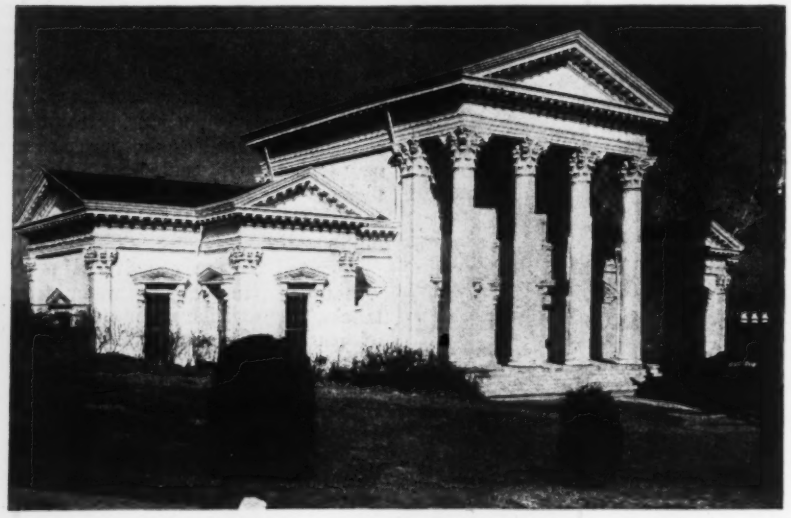


FIG. 1—RESTORED *to its original condition, the first pumping station of the Louisville Water Co., built in 1856, is a monument to beauty in waterworks construction.*

International Meeting on Hydraulic Structures

THE International Association for Hydraulic Structures Research, which was founded at Brussels in September, 1935, (*ENR*, Dec. 15, 1935, p. 855.) plans to hold its first international meeting at Berlin Aug. 30-Sept. 1. The two principal topics of discussion will be the use of distorted hydraulic models and bottom load and silt.

The association plans to start issuing semi-annually a bulletin, "Current Work in Hydraulic Structures Research," to be published in English, French and German. Hydraulic research in the United States and in the U.S.S.R. which is now reported in the "Current Hydraulic Laboratory Research in the United States," and the corresponding bulletin issued in the Soviet Union will not be reported.

Distribution System Design

CLARENCE GOLDSMITH and GEORGE TATNALL

Assistant Chief Engineer and Engineer of the National Board of Fire Underwriters, Chicago

A GOOD pipe layout should provide an adequate domestic supply during peak load periods as well as sufficient flow when needed for fire protection

THE vast network of underground pipe which represents a major portion of the investment in a waterworks system may be out of sight but it is seldom out of mind. It is the vital link in conveying water from the source of supply to the places where it is needed for domestic use and fire protection. Domestic supply and fire supply demands on a distribution system are quite different; in the smaller towns and in cities up to about 70,000 population the demands for fire protection are the governing factor in the design of both the arterial feeders and of the intermediate gridiron layout. As cities increase in size the consumption demand, particularly that in the peak-hour, becomes the controlling factor to be considered in the design of trunk mains and arterial feeders, although the gridiron in residential districts is largely determined by fire demands.

Design considerations

Distribution systems must be designed from the standpoint of furnishing suitable service to the consumer and providing adequate fire protection. Reliability is also an essential factor. No breakdown that may reasonably be anticipated should result in serious impairment of fire protection, nor should it cause pressure reduction to such an extent as to handicap satisfactory domestic service.

In the design of a new distribution system the demand upon it must be based on (1) a forecast of the population to be supplied, (2) a suitable per-capita average consumption figure according to the size and character of the municipality, and (3) pre-determination of the necessary fire flow in the different parts of the city. In determining consumption demands the trend toward increased use of water for refrigeration and for air conditioning should be taken into account. This makes it advisable to amend the previously accepted increases over average daily consumption to cover maximum daily and maximum hourly rates. Generally it has been considered that the maximum day would be at a rate of 50 per cent in excess of the average, and that the maximum hourly rate could be considered as from 50 to 75 per cent in excess of the maximum day. These figures still may be suitable in the smaller towns, but experience in cities has shown that the maximum day demand is more likely to be 100 per cent in excess of the average and the maximum hour 100 per cent above the maximum day.

Fire-flow requirements for the central business district are based on the generally accepted formula of the National Board of Fire Underwriters, i.e., $G = 1{,}020\ \sqrt{P}\ (1 - 0.01\ \sqrt{P})$, where G equals gallons per minute and P equals population in thousands. Exceptional conditions occasionally warrant deviation from this formula, but it is applicable to the average city. Outside of the central business district the amount of water required for fire protection depends on the character and congestion of building construction. General rules can be specified, but only at considerable length; it is therefore advisable to consult the National Board of Fire Underwriters or a local bureau for information.

Water for fire protection should be available at residual pressures ranging from 50 to 75 lb. (depending on the prevailing heights of buildings) if reliance is to be placed on fire streams direct from hydrants, and at 20 lb. (or under special conditions, 10 lb.) when supply is to fire engines. Present-day practice is so universal in equipping fire apparatus with pumps that the 20- or 10-lb. pressure is almost always used.

After quantity and pressure zones have been established in the various parts of the system, and fairly accurate knowledge of the elevations to be supplied is obtained, it becomes simply a matter of mathematical calculation to determine the necessary main sizes. These calculations may be made by hydraulic tables or by slide rule. For complex systems the work may be simplified by methods of graphic or electrical analysis which have been developed recently, and for the design of a local gridiron empirical textbook formulas are available.

Layout based on a "tree" system is inherently unreliable; it is essential that feeders be in duplicate from the source or sources and looped. If provision is not made for present capacity to meet ultimate demands, the design should be such that necessary reinforcing mains can be installed without uneconomic paralleling of other pipe.

Based on the background of twenty-five years of experience, engineers of the National Board of Fire Underwriters have drafted requirements for distribution systems which are set forth in a standard schedule for grading cities and towns. These standards require (1) arterial feeders, considered to be 12-in. or larger mains, at intervals of not more than 3,000 ft. and looped; (2) the elimination of dead ends in so far as practicable; (3) the use of no pipe smaller than 6-in. in the gridiron and a liberal percentage of 8-in. where the gridiron is apt to remain irregular for some time; and (4) the cross-connection of mains in the gridirons at frequent intervals, depending somewhat on the prevailing pressures on the system. These are not hard and fast rules. For instance, 10-in. pipe may be used for feeders if more closely spaced, and a gridiron composed entirely of 8-in. pipe more widely cross-connected than 6 in. mains may be installed.

Checking existing systems

The above statements have been based on the assumption of the construction of an entirely new distribution system. In actual practice it is rare that such projects arise. More often the distribution problem consists of analyzing an existing system, determining the strong and the weak points and contriving means of reinforcement at a minimum of expense or economic waste. In such work the use of recording pressure gages that provide a continuous record of actual pressures at strategic points is a valuable aid in determining inadequacies of supply. In a study of available fire flow the methods of calculation previously enumerated may be used but their application is often laborious.

Many of the larger cities have come to accept the recommendation of engi-

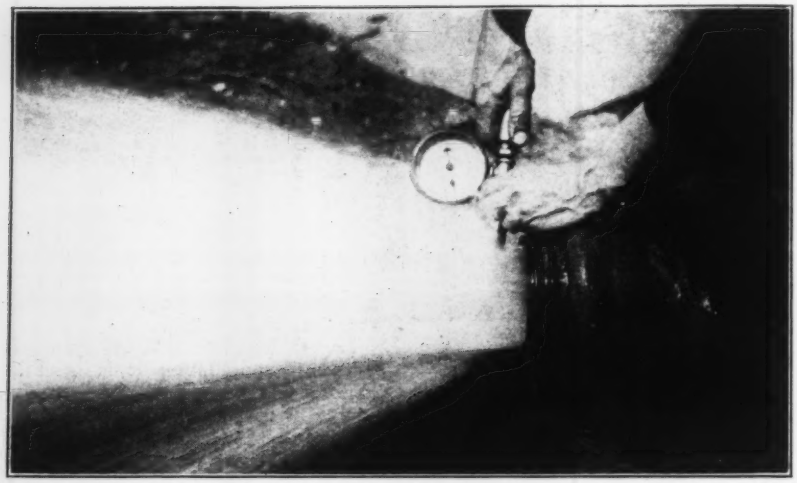


FIG. 1—MEASURING FLOW *in a section of the system with pitot tube meter inserted in the jet issuing from an open hydrant.*

neers of the National Board of Fire Underwriters that actual fire-flow tests are the simplest and the most practicable means for studying needed improvements. Detroit, Chicago, Milwaukee and others have made comprehensive sets of fire-flow tests, covering all important districts and all other locations suspected of weakness. Fire-flow tests, where a measured quantity of water and a definite drop in pressure are observed by simultaneous readings on pitot and on ordinary pressure gages, respectively, allow a ready calculation of an equivalent main size from the source or nearest main feeder. By combining any size of proposed main with this calculation, the results of an improvement can be reasonably predicted.

While it is not claimed that these tests approach laboratory accuracy, they are sufficiently precise to permit the selection of the proper commercial pipe size. On old systems methods of analysis that depend on calculation alone are hampered by such factors as varying pipe coefficients and incomplete records which are no assurance that mains are actually connected where shown or that gate valves are closed or open. Conditions such as this will upset calculations.

Proper gate valve spacing is essential for a distribution system if it is to function properly. It is of little avail to have a carefully designed piping layout if some break, addition or repair to the system makes it necessary to shut off a large section at a crucial moment. Valves on arterial mains should be spaced every quarter mile. In important districts valves on minor distributors should be located at every block or not in excess of 500 ft. In other districts the shut-off section may include two sides of a single-block or a maximum of 800 ft.

Some typical examples of distribution system gridiron layouts are shown in Fig. 2. A quarter-section design now being installed in Chicago is shown in Fig. 2A. This arrangement of mains, although operated under a prevailing pressure of little more than 30 lb., can deliver at least 5,000 g.p.m. around any block at a residual pressure suitable for fire engine supply. In Fig. 2B is shown a quarter-section of a recent installation in Milwaukee which, with a prevailing pressure of 65 lb., delivers 8,500 g.p.m. A gridiron section in Aurora, Ill. is shown in Fig. 2C. Before the installation of the 14-in. main in the center, 2,100 g.p.m. was available at Pennsylvania Ave. and Plum St.; since the reinforcement, 4,500 g.p.m. may be obtained under a prevailing pressure of 55 lb. In Fig. 2D, from a city which had best remain nameless, is shown an isolated section of gridiron which, although under pressure of 75 lb., can deliver only 900 g.p.m.

These examples, taken more or less at random, are only a few of the arrangements which have been developed. Improvements in fire flow similar to the ones cited are continually being attained in cities from coast to coast. These results in design of new systems or in reinforcement of old may be attained by careful attention to domestic and fire demands. Adherence to the cardinal principle of reliability in the looping of feeders and in providing sufficient gate valves will assure the satisfaction of at least a goodly portion of these demands under abnormal conditions. Much improvement work is needed in the older, outgrown distribution systems and commendable progress in this direction is being made.

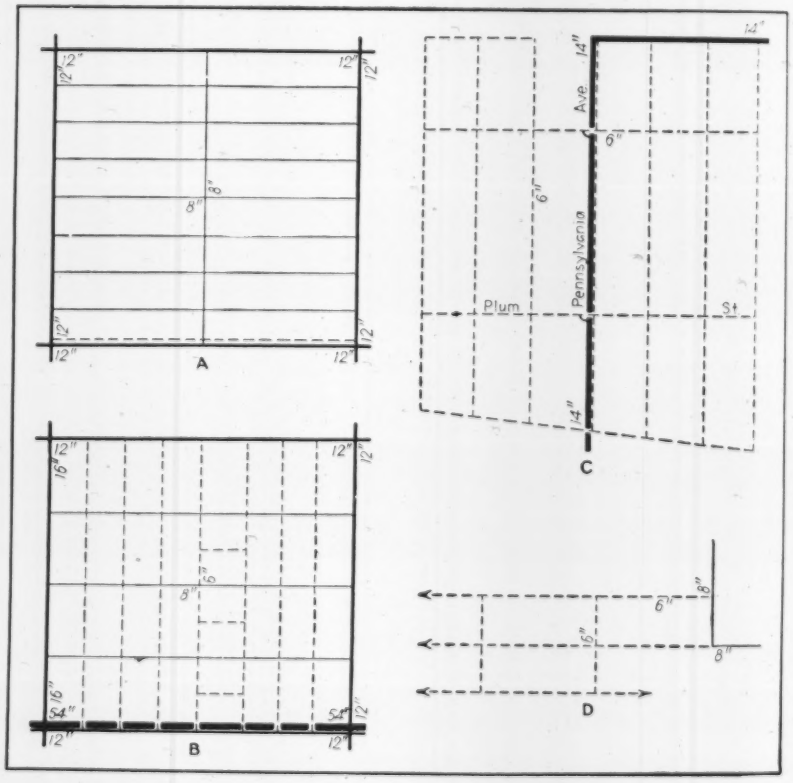


FIG. 2—GRIDIRON LAYOUT SYSTEMS *showing water pressure and quantity obtained; (A) 5,000 g.p.m. at 30 lb.; (B) 8,500 g.p.m. at 65 lb.; (C) 4,500 g.p.m. at 55 lb.; and (D) 900 g.p.m. at 75 lb.*

Control With Valves

D. D. GROSS
Chief Engineer, Board of Water Commissioners, Denver

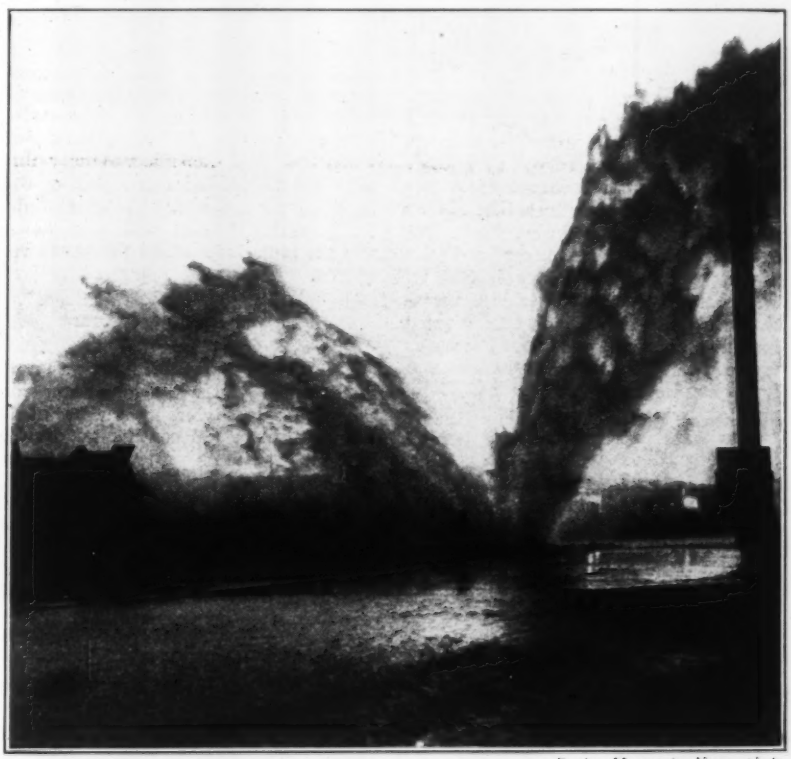
REGULATION of flow to eliminate pressure difficulties and provide safety features can be accomplished by suitable valves in strategic locations

WHEN a new water plant or an important addition is being planned all the factors influencing the service to be rendered are investigated and the work designed to meet these requirements. After a few years of service, however, conditions may change—new consumers are added, old consumers increase their demand and minor extensions are made. And gradually the efficiency of the plant is impaired. For these and other reasons the person responsible for operating a water supply system must ever be on the alert to anticipate changes and plan remedial measures. The Denver system is now in the process of adding new facilities to enlarge the scope of its service, and among other things the distribution system is being extended. Availability of modern regulating equipment has been taken advantage of in fitting the new feeders into the existing distribution system.

As an example of what changing conditions may do to a distribution system, the situation in a sparsely settled district on the outskirts of Denver may be cited. When the water supply was installed it adequately met needs with some provision for the future. After a few years the building of new houses, the extension of the mains further up the hill and the growth of industrial consumption made it necessary to provide more water. A storage tank was installed in which the available flow at night was stored for use the following day. The district to be served from the tank was segregated from the rest of the plant by closing gate valves in the street mains. A check valve was placed in the main coming from the pumping station located several miles away. All went well for a time, then it because necessary to build a new pumping plant to supplement the distant station that had supplied this district. Both stations received water from the same flow line, which did not have sufficient pressure to give satisfactory service without pumping. All these improvements could have been made in the beginning, but by making them from time to time, as more water was needed, considerable money was saved.

Regulating pressure

A 48-in. pipeline several miles in length, installed as a flow line extending from a filter plant to a city distributing reservoir, illustrates a different case of growth requirements. This line was not designed to withstand static head. The valves for regulating the flow of water were placed at the filter plant at the upper end of the line. Within a short time a community of several hundred houses was built at the highest point along this pipe line. When the consumption in the main part of the city was high this conduit contributed 25 m.g.d. and the community got sufficient water; but when the consumption was low the pipeline carried 5 m.g.d. and the community on the high point of the line got no water—with small flows there was no pressure at the high points. A pressure regulator valve was installed in the reservoir end of the pipeline which served to maintain the same pressure in the pipe at the high point when the flow was small as formerly existed with the high flow. As a safety measure a relief valve was installed at a low point on this line, set to open and discharge when the pressure got too high.



Rocky Mountain News photo

FIG. 1—IT HAPPENED ONE NIGHT *when wood staves broke out in a feeder conduit carrying water at 90 lbs. pressure. An automatic check valve in the line would have quickly halted damage.*

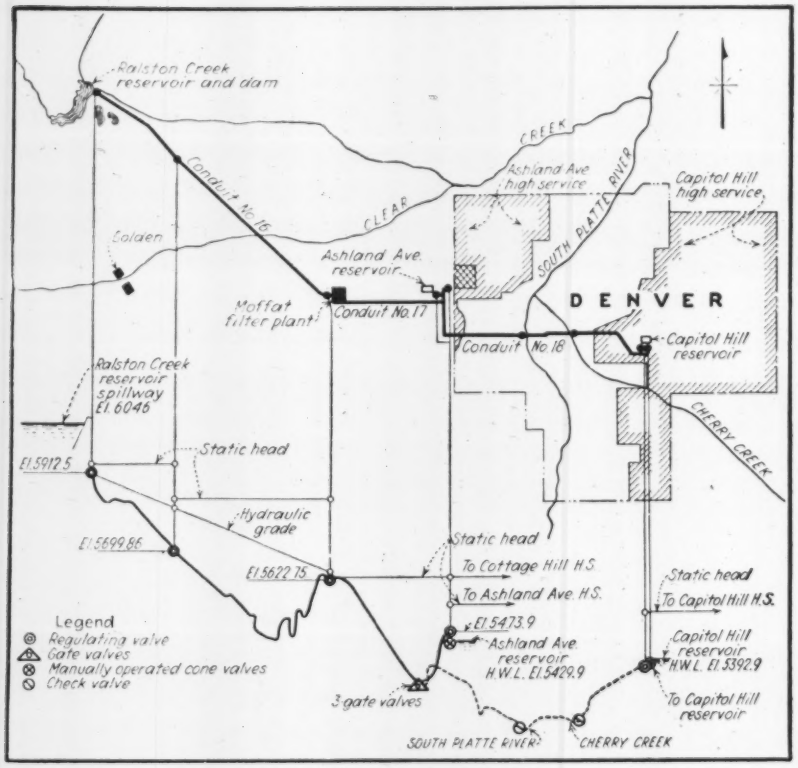


FIG. 2—REGULATING VALVES *on the new water supply line from Ralston Creek reservoir to Moffat filtration plant.*

Water flows into the Denver system by gravity. Reservoirs are located on each side of the city at high points that can be reached by gravity. Higher districts are served by booster pumps, taking water from these reservoirs or the flow lines that supply them. The extreme difference in elevation between the lowest and the highest points in the city is 350 ft. In order to prevent too wide a variation in pressure, the city is divided into five districts or zones. Pressures range from 35 lb. to 90 lb., with a few extreme cases as low as 22 lb. and as high as 120 lb. The National Board of Fire Underwriters reports an average of 69 lb.

One of the districts is served by a pumping station, balanced by a tank placed on the highest hill in Denver. When first installed everyone was satisfied with the service. Then some of the citizens began climbing the hill with new houses, getting closer and closer to the tank and almost on an elevation with it. Presumably they were after a better view of the mountains, but all the time they were getting poorer pressure on their water faucets. When it came time to sprinkle the lawns they said they got no water at all. As a temporary means of relief the pressure at the pumping station was increased during the irrigation hours as some cities do during a fire. To prevent the tank from running over when this higher pressure was turned on an altitude valve was installed in the inlet-outlet pipe at the tank. This valve closed when the tank was filled. Under this plan the tank idled along during the busy part of the day, but at night the pumping station was shut down and the tank supplied all the water required.

Valves in new system

Denver is now bringing a new water supply from the headwaters of the Colorado River by means of a tunnel through the continental divide. This is a PWA project, known as the Moffat Water Tunnel Diversion Project, the construction of which is in charge of H. S. Crocker, consulting engineer. (See *ENR*, Sept. 12, 1935, p. 357). The water will be delivered into Ralston Creek reservoir, located in the foothills above Denver.

The conduit system delivering water from this reservoir into the city distribution network is provided with an interesting layout of regulating valves to control the flow of water. At the present time 32 per cent of the water delivered to the city by gravity passes through booster pumping stations to serve the higher districts. When the new supply reaches the city most of this pumping will be eliminated. It is necessary for this piping system to deliver water to three high-service districts at different pressures in order to give them the service required. It must also deliver the balance of the water to the gravity system at still another pressure.

These important functions of the conduit system are to be performed automatically by regulating valves. Furthermore, in designing the installation of these valves provision has been made against surge or water hammer in the conduit lines. Regulating valves of the cone or plug type were selected. Most of them are hydraulically-operated but in some locations the water pressure cannot be relied upon for operation under all conditions. In these cases the valves are provided with oil accumulators for operating the hydraulic cylinders with oil, and are independent, so far as power for operation is concerned, from the flow of water in the pipelines.

Surge relief

To relieve surges which might result in dangerous water hammer, relief valves, either singly or in pairs as the size of the pipe requires, are provided on the high-pressure side of all regulating valves. To prevent damage to the valves or piping from cavitation, circulating water pipes are provided on the downstream side of all regulating valves. The longest stretches of pipe are provided with automatic check valves of the cone type; these are located on each side of river crossings and at other strategic points. In the event of a break in the pipeline these valves will automatically close and shut off the flow of water.

From the Ralston Creek reservoir a 42-in. concrete conduit, 8½ mi. long, with a capacity of 65 m.g.d., delivers water to the new Moffat filter plant. (Fig. 2). The flow is controlled by three regulator valves, one located near the reservoir, one near the midpoint on the line and one at the filter plant. The regulator at the filter plant is float-controlled, its operation being regulated by the height of water in the coagulation basin. (Fig. 4).

The filter plant has a capacity of 57 m.g.d. and is provided with a 10 m.g. concrete filtered-water reservoir. From the filter plant a 63-in. steel pipe, with a capacity of 87 m.g.d., leads toward the city. At 3.3 mi. from the plant this line divides into two branches. One is a 54-in. steel pipe (capacity 33 m.g.d.), 1.4 mi. in length, leading to the Cottage Hill higher-service district and the Ashland high-service district. The second branch, (a 57-in. steel pipe, 2.4 mi. long, capacity 54 m.g.d.), delivers

water into a 54-in. concrete pipe, 4.1 mi. in length, which in turn discharges into the Capitol Hill high-service district. This latter connection is made at the present Capitol Hill pumping station.

The flow of water from the conduit line into the discharge piping at the Capitol Hill station is regulated by two reducing valves, one 36-in. and one 24-in., which reduce the pressure from 104 lb. to 60 lb. A third 24-in. regulating valve located at the pumping station regulates the flow of the water into the Capitol Hill reservoir. It is provided with dual control, that is, it will not release any water from the high-service conduit into the reservoir when the pressure in the high-service district falls below 60 lb., and it will not release any water into the reservoir unless there is space in the reservoir to receive it. The first function of the valve—not to permit any flow of water from the conduit line into the reservoir unless the pressure in that conduit is in excess of 60 lb.—is performed by a mechanism of the pressure-valve relief type. The second function is accomplished by a float. When there is space in the reservoir available for the storage of water the float releases the interlock between the two systems of control and permits this valve to operate as a relief valve.

At the Ashland high-service district a similar condition exists with this difference—the Cottage Hill higher-service district will be supplied with water without the use of reducing valves and the flow of water into the Ashland reservoir on the gravity supply will be manually controlled through a cone or plug type valve. (Fig. 1). Since the capacity of the pipeline is not sufficient to supply the peak demands in the Capitol Hill district, it will be necessary to continue the operation of the Capitol Hill pumping station during the irrigation season.

L. R. Howson, of Alvord, Burdick & Howson, consulting engineers, has prepared a study showing benefits that can be derived by elevated storage in the Capitol Hill district. (Fig. 3). The present maximum demand of this district is at the rate of 100 m.g.d. The new supply will provide for 54 m.g.d. and the balance will be supplied by the Capitol Hill pumps. If 4 m.g. in elevated storage capacity was installed, practically all pumping could be eliminated at the present time. The cost of this storage would be about $150,000 for each 2-m.g. storage tank.

It is estimated that the saving in pumping cost due to the new conduit line will be $27,000 per year; with the installation of one storage tank the saving would be an additional $9,000. In future operations, with the installation of three storage tanks, the saving would be an additional $18,000 or $9,000 per year for each 2-m.g. storage tank required. Probably the greatest saving would be in the cost of future installations of additional feeder mains. It is difficult to evaluate the money worth of the satisfaction obtained from more uniform pressure obtained when properly located tanks are in use.

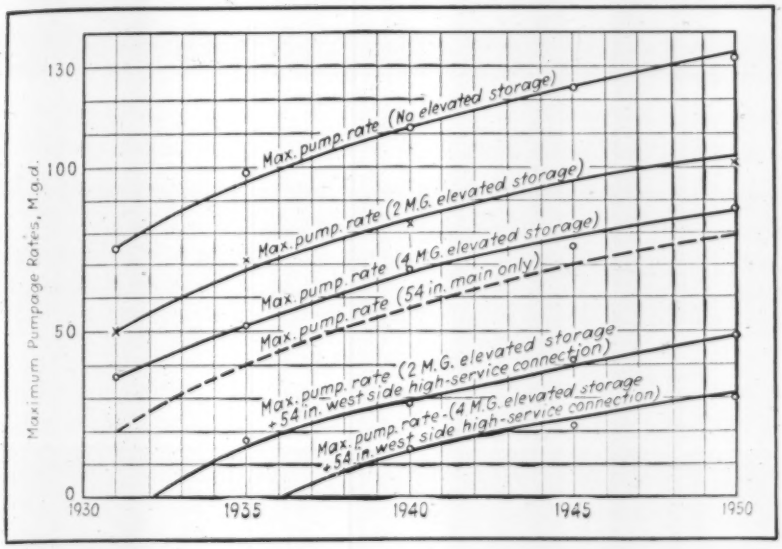

Maximum Pumpage Rates, M.g.d.
130
100
50
0
1930
1935
1940
1945
1950
Max. pump. rate (No elevated storage)
Max. pump. rate (2 M.G. elevated storage)
Max. pump. rate (4 M.G. elevated storage)
Max. pump. rate (54 in. main only)
Max. pump. rate (2 M.G. elevated storage + 54 in. west side high-service connection)
Max. pump. rate (4 M.G. elevated storage + 54 in. west side high-service connection)

FIG. 3—BENEFITS *derived in reduced pumpage by the installation of elevated storage facilities in the Capitol Hill district.*

Manual valve operation, along with other duties, is performed by servicemen supplied with pick-up trucks equipped with tools, maps, etc. These cars are also provided with short-wave radios. The Police Department of Denver maintains a radio broadcasting station and accommodates the Water Department by broadcasting instructions to its servicemen. This radio connection makes it possible to reach servicemen in case of an emergency at any time.

Despite the splendid efficiency of the regulating valves in the Denver system it is necessary that they be given constant attention and regular service, the same as is given any other piece of machinery. It is customary to make regular inspections and operations of all valves, for which a special crew is maintained. A card index file is kept in which there is a card for each valve in the plant, with space for notations as to its inspection and repair.

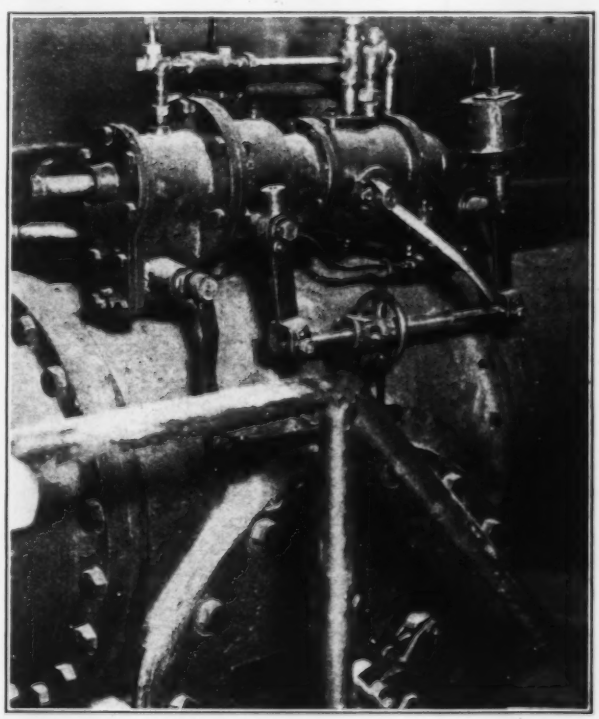


FIG. 4—CONE VALVE *regulating mechanism is actuated by a float located in the coagulation basin.*

Meter Maintenance

CLEM A. GALLAGHER

Superintendent of Service and Meters, Louisville Water Co., Louisville

AN OUTLINE of experience and successful practice in the development of an effective program of meter testing, repairing and record-keeping

EVERY effort is made, and many thousands of dollars are spent, to improve construction, pumping, purification, administration and other essential functions of a water utility. At every convention these elements of water service are emphasized; and every magazine aids their furtherance and perfection. Yet—and this is a paradox—the equipment that determines how much can be collected for service rendered seems to be the forgotten feature of the waterworks field. Less is known, less is said and less is done about water meters than about any other phase of water service.

Every municipality and every honest commodity dealer is genuinely concerned as to the accuracy of scales and other measuring devices. But when it comes to the meter measurement of water consumption an attitude of indifference, ignorance, doubt and fear is encountered. The two premises that meter measurement of water is the only honest, dependable and business-like procedure, and that "as your meters go, so goes your revenue" are self-evident and the conclusions inescapable. Why then the indifference? Principally because many waterworks men actually fear to undertake meter programs. They are convinced that such a definite maintenance set-up is too expensive and too complicated. It is astonishing to find how little is known about water meters by waterworks men whose bread and butter depend upon the faithful and accurate movements of an unimposing little register atop the meters. Many a useful meter has been consigned to junk because it has stopped, when only a particle of grit has hampered the action of the disc of piston, or a register has become tired of its struggle with mud and grease. In most cases it would have required only 15 min. of work to restore the meter to its original state of accuracy and usefulness.

There is no valid reason why every water property, large or small, municipal or private, should not have a definite, efficient and consistent meter testing and repair program. In proportion to value returned, such a program is cheaper and simpler than any other waterworks maintenance setup. It is one of the few maintenance jobs that will pay for itself and leave dividends reminiscent of prosperity.

The meter program at the Louisville Water Co. (stock wholly owned by the city) has demonstrated that all meters should be cleaned, repaired and tested regularly to insure maximum accuracy and so maximum revenue. It has been found to be simple, practical and profitable. In the process of taking the meter from the ground, passing it through the shop and getting it back into the ground, four phases must be considered; exchange, test, repair and records of each operation.

Exchange program

In Louisville two men, with panel body trucks, exchange 75 meters a day and bring the replaced meters to the shop. Another man and truck takes care of complaints such as stopped meters, broken counters, etc.

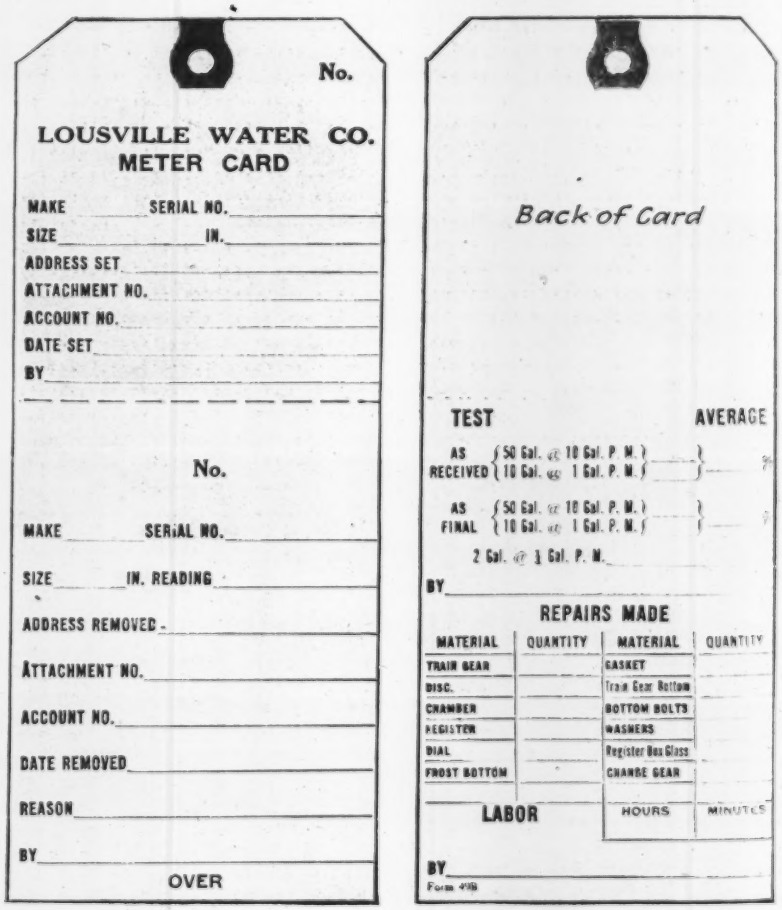


FIG. 1—RECORD CARD *which is attached to and remains with the meter from the time it comes into the shop until it leaves.*

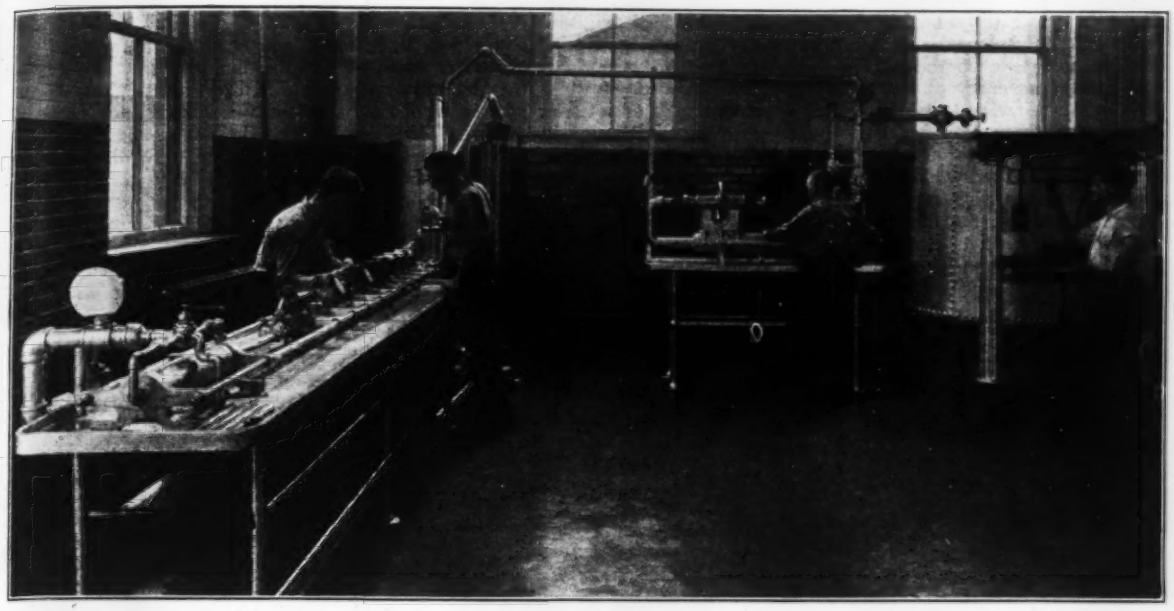


FIG. 2—METER TESTING EQUIPMENT *in one corner of the Louisville shop. At the left is a bench mounting for simultaneous testing of ten meters; and at the right is a single-meter test rig.*

A simple card has been devised on which to record all the information necessary to insure an accurate and permanent record (Fig. 1.) This card is perforated midway, with a wire at the top for securely attaching it to the meter. The cards are numbered, used and filed consecutively. On the front of the card at the top is a record for the meter reset after it has been repaired, tested and okayed. Space is available here for recording the make of the meter, the serial number, size, the address at which the meter was reset, the service attachment number, the account or meter book and page number, the date reset and the signature of the man resetting the meter. The lower half of the card on the same side has the record of the meter removed with make, serial number, size, reading, address from which it was removed, service attachment number, account number, date removed, reason for removal, i.e., exchange, frozen, out of order, etc., and space for the signature of the man removing the meter. On the other side of the card the upper half is blank, while the lower half contains a complete record of the meter test and repair.

Each meter coming into the shop has this attached card securely wired to the casing; this same card remains with that one meter from the time it leaves the ground at one location until it is returned to the ground in another place. This plan obviates lost cards and garbled records.

Each meter received in the shop is tested as received and finally tested after it has been repaired. Every meter is thoroughly cleaned and repaired irrespective of its first test average. A removed ⅝-in. meter is tested with 50 gallons of water at the rate of 10 g.p.m. and with 10 gallons at 1 g.p.m. The meter tester places both percentages on his card as well as the average of the two. The meter is then sent to the repair bench to be cleaned and repaired. The lower half of the card contains a list of the repairs made, parts replaced and the time consumed. The material is listed on the card with a corresponding space for the quantity of each part used and the bin number from which it was taken. As a consequence each man while repairing a meter must put down just what new part or parts he used and how long it took him to finish this one meter. The meter repair man then signs the card and the meter is returned to the testing table. It then goes through its final test of 50 gallons at 10 g.p.m. and 10 gallons 1 g.p.m. Finally it is checked at ¼ g.p.m. The averages are again noted and averaged and this part of the card is then signed by the chief tester.

If the meter does not register within 2 per cent it is returned to the bench for a further overhauling. If it registers satisfactorily the card is severed at the perforation marks and the lower half returned to the meter record office. The signature of each foreman definitely places responsibility for errors under each classification. The information for these field and test cards is transcribed to the regular permanent meter cards and the original cards are then filed according to their test number.

The top half of the card remains on the meter until it is taken out to be reset. The man resetting this meter or exchanging it for another, fills out the card, disconnects the wire and card from the meter, signs the card and returns this reset information to the meter record department.

This is the complete cycle for the exchange program. The simple card affords not only a method of double checking each step, but also places responsibility where it should be fixed. The men exchanging meters take out each day just as many tested and repaired meters as they will exchange, thus keeping the shop free from too many meters piling up. At the present schedule each of the 51,000 meters in use in Louisville will be put through this process once every five years, although tests with Ohio River water and the type of meters used show that this period between tests could be lengthened appreciably.

Testing details

As noted above a meter is tested when received and after it is repaired. The size of the stream for the test depends upon the size of the meter. The meter testing table can handle ten ⅝-in., ¾-in. or 1-in. meters at a time. On an adjoining bench larger meters up to 6 in. in size are tested one at a time. The slower method of weighing for tests has been eliminated and only calibrated tanks and funnels are used. A hydraulic plunger keeps the meters in place. The test bench is so arranged that the stream can be varied anywhere from 225 g.p.m. down to 1/320 g.p.m. The low flow rate is secured with needle valves.

Recently the shop has standardized on the sweep-hand dials on all meters, for two reasons. First, it is much easier to detect a leak on any size

meter if it is equipped with a sweep-hand dial; second, and even more important, it speeds up the testing time and assures accuracy of the registers. The meter tester and his helper average more than one hundred ⅝-in. meters a day on standard tests.

A cycle is likewise completed here, since in the morning repaired meters are tested and in the afternoon those received are tested from the field. Thus the repair men on the bench work each day on the meters tested as received the previous afternoon, while in the morning the meter tester passes on the meters repaired the previous day. The records show that less than 1 per cent of the total number of meters repaired are unfit after repair and have to be returned to the bench. The promiscuous use of change gears is undesirable and is discouraged.

SERIAL NO. 749162 SIZE 5/8" MAKE —
PURCHASED May 15 1927 COST $ 8.60 TYPE —

DATE SET	LOCATION	ACCT. NO.	REMOVED		TESTED			REPAIRS
			DATE	READING	DATE	NO.	RESULT	
5/20/27	1234 W. Broadway	XX-456	4/15/32	251,000	4/14/32	1314	98.2%	$ .44

JOHN DOE XX-456 SIZE 5/8"
1234 W. BROADWAY. 12005
BET. 11TH. & 12TH.

MAKE	SERIAL NO.	INSTALLED		REMOVED		TESTED		
		DATE	READING	DATE	READING	DATE	NUMBER	RESULT
—	749162	5/20/27	0	4/15/32	251,000	4/14/32	1314	98.2%
—	312787	4/15/32	0					

FORM NO. 276 LOUISVILLE WATER CO. CONSUMER'S METER RECORD

FIG. 2—THE METER RECORD OFFICE *maintains a permanent file in which two cards are kept on each meter; one card is listed under the meter serial number and the other is classified according to meter location.*

Repair bench work

The next step in meter rehabilitation occurs at the repair bench. Five men work on this bench and each man has his own set of tools, a sink with running hot and cold water, individual brushes and a hose with a stop valve carrying compressed air of 7 to 10 lb. pressure. This air is piped from the garage and the pressure reduced by a valve installation in the meter shop. Compressed air at this pressure is most useful and practical for testing the operating smoothness of a meter as well as for ejecting particles. It likewise does away with the necessity of the men placing their mouths on the outlet or inlet to a meter. The meter bench is made of wood and covered with heavy galvanized iron. Above each man is an electrical reflector which illuminates his place of work exactly where he needs it most.

Each meter is placed in a separate pan to prevent the loss or mixing of loose parts. The manner of cleaning a meter is the old fashioned but effective soap-and-water method. The use of acid on any meter or parts is disapproved unless such procedure is absolutely necessary. It has been found that under the local water conditions incrustations can be satisfactorily and more safely removed by hot water, soap and elbow grease. No machining or reboring is done. Generally, for smaller size meters, replacement parts are the cheapest and safest to use.

Above the repair benches are placed marked and lettered compartments for the various parts of each size and make of meter. This arrangement is part of the permanent running inventory system. Each closed bin is numbered and contains a different part. When the men need any new part for any meter they must mark on their ticket the number of such parts used as well as the bin number from which it was taken. A regular inventory clerk can thus keep a daily record from these cards of just what parts were used and how many of each part remain in stock. He has a standard minimum of each part that should be kept in stock and can daily, or at a moment's notice, notify the department head what parts are needed and how many of each so that they may be requisitioned and ordered. Again, this inventory system, though simplicity itself, affords an easy check on costs, new parts required, etc.

Each man averages from 15 to 20 completely cleaned and repaired meters a day. The average cost, not including overhead, runs 50c. a meter for tests and repairs. About 50 new disks are needed each month. Bottom bolts and gaskets need replacement most often. A meter is scrapped only after its retention is shown to be a liability. Some meters have been overhauled and cleaned which have been in the ground 40 years and more.

One man at another bench takes care of the registers, oiling and setting them back to zero. The counters are soldered to avoid ruining the gears by running counters back speedily with a motor-driven disk. The registers of all meters after having been cleaned, are dipped in hot oil and then drained.

Maintaining good records

On the same floor with the test shop is an inclosed meter record office. The head of the meter department and clerks keep complete records of all meters. Two cards are kept on each meter; one according to make and serial number and one according to the book and page number in the meter reader's books. All information—address, make, size, serial number, purchase date and price, sets and resets, tests and repairs—are kept on these cards. Information concerning any meter in service, in the stock room or in the shop is available at all times. The city is divided into districts, lettered alphabetically and a reference from card to meter book gives all information concerning readings, leaks, etc. The two sections of the numbered cards are filed separately after the information on them has been transcribed to the other set of cards. These test and repair cards give the final shop information on any particular meter. This system of checks and balances assures accuracy, permanency and simplicity. All necessary information is always at hand and any meter can be traced from the moment it is received until the time it is scrapped.

At present, Louisville has in the ground 51,000 meters making the system 76 per cent metered. When purchasing new meters three things are taken into consideration: accuracy, endurance and interchangeability. To find out just what meters would be most dependable under the local water conditions a series of tests is conducted with new stock meters. Ten of each make are tested at a time. They are tested as received on flows of 10, 1 and ¼ g.p.m. These same ten meters are then placed in an endurance test box in the basement and the water used in the company building is allowed to run through them until they register an average of 500,000 gal. This flow in the building can be varied as desired. The meters are taken back to the shop and the first test schedule repeated. These figures are averaged, with emphasis on the average percentage of inaccuracy, and blue prints made for permanent records. New meters may be taken apart and their parts interchanged. They are run for 100,000 gal. and retested according to the first test schedule. They may be run on an absolute endurance test until one or more meters of any series breaks down. The meter that fails is taken apart and the cause of the breakdown investigated. From all of these tests the company has obtained for most standard makes of water meter enlightening, practical facts.

Figures on Louisville water and conditions in many of these tests have been startling and seem to prove one thing conclusively, namely that the specifications of the American Water Works Association for ⅝-in. cold water meters are entirely too lenient. A well-constructed water meter should register much better than 90 per cent on a ¼-g.p.m. stream. Recently a meter under-registration survey was made. At one time 300 meters which had been in service five years or longer were brought into the shop and tested as received. The averages were surprising inasmuch as the average percentage of inaccuracy on all flows for all meters up to and including a ¼-g.p.m. flow was far above standard requirements for new meters.

It has been the endeavor in this entire meter setup to aim first at thoroughness and simplicity. We believe we have accomplished this purpose and through the cycles described are able to test and repair water meters regularly, accurately, efficiently and economically. The cost of the program is small compared with the additional revenue gained, not to mention the life added to the meters.

Finding Lost Water

EDGAR K. WILSON
Chief Engineer, The Pitometer Co., Engineers, New York

WASTE water surveys designed to eliminate leakage losses, faulty meters and unauthorized use increase system efficiency and revenue income

EVERY waterworks system, some more than others, is troubled with "lost" water. This unaccounted-for difference in the original supply and final consumption figures may be the result of leakage from reservoirs, mains and services, waste in unmetered premises, unauthorized use through unmetered sources, and water which is not properly registered as it passes through meters. Water used for extinguishing fires, flushing hydrants and sewers, sluicing ditches, and for supplying public buildings may be considered lost water—as far as revenue goes—but by means of intelligent estimates or the installation of meters a reliable accounting can be made for these legitimate uses.

How to control and eliminate unnecessary losses in water is a problem that is becoming of greater importance every year. Failure to curtail waste results not only in increased pumping and water treatment costs but may be the cause for making premature extensions and enlargements. It is essential, therefore, that every waterworks manager desiring maximum efficiency in his plant, take steps not only to reduce waste to a minimum, but make such reduction permanent.

The fact that a large percentage of water supplied to municipal distribution systems could be attributed to leaks and willful waste was first recognized by George F. Deacon of Liverpool, England, who in 1873 devised a recording meter for water waste surveys and introduced a system of district inspections. His meter is still employed in England and has been used in this country.

A more convenient and economical method of making district surveys, or water waste surveys as they are usually called, is by use of pitot tubes so designed that they may be introduced into a pipe through a standard corporation cock without shutting down the main. Proper connections transmit the differential pressures set up by the velocity of the water to a manometer or to a similar recording apparatus. By the use of orifices opening both up and down stream the differential pressures are increased over those obtained with pitot tubes having a static side orifice. Better definition is thus obtained, especially at low velocities.

While the general method of conducting a water waste survey is the same in all cases, each system requires special consideration so that individual problems receive proper attention. If the water is pumped, tests of the pumping equipment should be made to determine the amount of slip, or overall efficiency. Slip is often surprisingly large, in some cases amounting to 25 per cent or even more of the plunger displacement. In a gravity system simultaneous measurements are made of the flow at each end of the conduit lines and a comparison between the two measurements shows whether leakage exists.

District tests

After this preliminary work has been done the distribution system is divided into districts. The size of each district is dependent on the available feed mains, the class of consumers, the location of valves, and the fire hazard. One main is selected to supply the district and all other feeder mains are closed so that all water entering the district must pass a selected gaging point. A recording device is set up at this point and a continuous 24-hr. measurement is made of the water entering the district. This record shows the rate of flow at all times during the test and from it the total quantity of water is computed. The minimum night rate taken from this record and the total flow

forms the basis of determining the necessity for further investigation in the district.

Large commercial meters are read during the hours of minimum use and the results are included in the study of the records. Districts in which the minimum night rate is less than 40 per cent of the average rate of flow are usually in excellent condition. Where the ratio is between 40 and 50 per cent the condition is good but the district may need further attention. If the ratio is above 50 per cent night subdivision is usually necessary. All of these percentages depend on local conditions and are subject to revision by the engineer after careful study of each case.

Night test procedure

Where night subdivision of districts is found necessary the investigation is made during the hours of minimum flow as shown by the district measurement chart. At this time the consumption is at the lowest point and the flows obtained, other than commercial use, may be taken as evidence of leakage from mains, services, or house fixtures. The subdivision is made by cutting off sections of the district for a short time while the rate of flow is recorded. Valve operations are timed and if the recorder shows a drop in the flow at the time a section was shut off the rate of flow into that section is measured. From the results of this subdivision test the engineer obtains the following information: (1) Blocks which are free from leakage and require no further attention; (2) Blocks where small flows indicate fixture leakage and which require inspection of house fixtures; and (3) Blocks where the flow is large, which usually indicates main leakage, commercial use, service leaks, or a large number of fixture leaks.

All these conditions are then thoroughly investigated by the engineer with the aid of aquaphones, geophones or other types of listening devices. Underground leaks are located and repaired, owners of properties where fixture leaks exist are given a definite time in which to make repairs, and commercial plants are investigated to determine whether the water supply is properly metered. In the course of a leakage survey all large meters are tested in place. Frequently the correction of errors of registration is found to add substantial amounts to the water company receipts.

Manufacturing plants are tested for unauthorized use of water, and it is not unusual to find that large quantities are being consumed through fire lines or through connections made by ignorant or unscrupulous employees. In such cases sufficient evidence is obtained and so presented that collection of back charges for unauthorized use is usually not difficult.

FIG. 1—BROKEN MAINS *can generally be traced to careless laying on sharp rock. This 6 in. pipe was broken clean across and wasted 100,000 gallons of water per day before it was discovered.*

While the principal objectives of a water waste survey are to reduce the cost of operation, to defer the need of extensions or development of new supply, and to increase the revenue, there is an added value the importance of which cannot be too strongly emphasized—namely, specific service information in regard to the distribution system which can be obtained in no other way. For instance, during the course of a leakage survey about 75 per cent of the valves are operated, and very often it is found that, through carelessness, valves have been left partially or entirely closed on important distribution mains. The discovery and opening of these valves, as a result of the testing procedure, has been the means of increasing pressures in sections where previously the supply was inadequate, thus improving fire protection without added cost.

In addition, the survey makes it possible to study the flow in trunk mains and to determine whether or not the system is well balanced. In many cases it is found that where one main is overtaxed, with a corresponding loss of pressure, another main may be of little or no help to the general distribution. This condition can often be rectified by simple valve operations or by making inexpensive water connections to the main feeder.

A survey is also of value in determining whether or not distribution reinforcement is needed for the system in certain sections. Plans for reinforcing the distribution system should always be preceded by district flow measurements. This furnishes a sound basis by which the sizes and locations of needed mains can be determined. The correction of errors in the pipe map is another by-product of a water waste investigation, for in isolating and subdividing the districts any discrepancies in records are quickly discovered.

Locating the losses

The methods employed for locating specific leaks vary with the conditions. When it is known that underground leakage exists in a given block, whether determined by a waste survey or suspected from complaints of residents who are troubled by noise on their fixtures, several methods may be used for locating the faulty condition. House inspections will reveal the condition of interior plumbing; listening devices applied to valves, hydrants, service curb-cocks or to the ground surface will often give a definite clue to the faulty connection, or at least considerably limit the size of the area under suspicion. It may then be necessary to drive iron bars, preferably close to and at intervals along the axis of the pipe; these bars serve as listening posts and observation points where soil moisture conditions

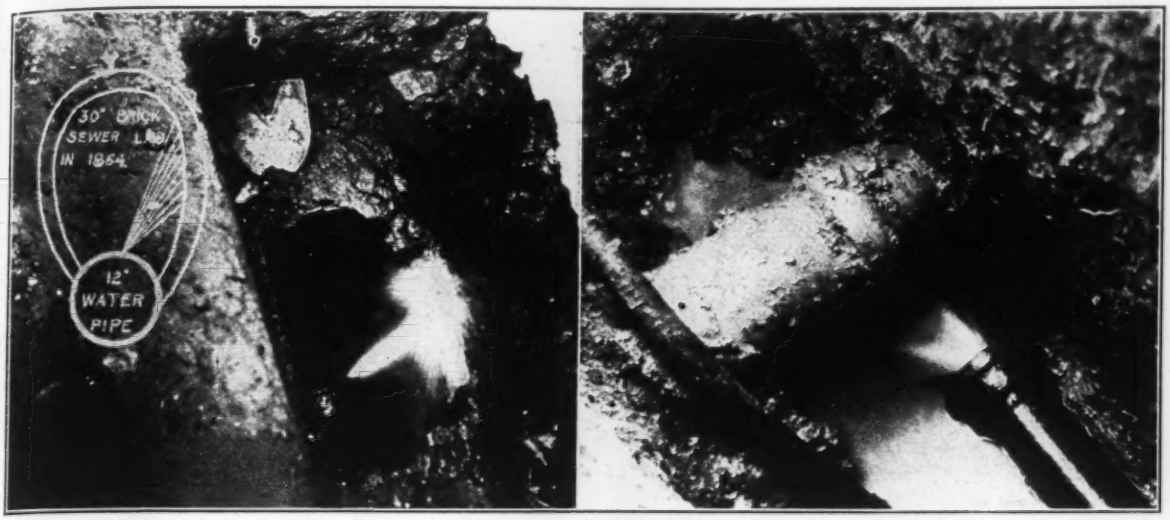


FIG. 2—JOINT LEAKS *discovered in the course of a waste water survey. At the left is shown an unusual condition—a 12 in. water pipe laid in the invert of a brick sewer; this leak amounted to 73,000 gallons per day.*

can be checked. When these methods are used by an experienced operator it is rarely necessary to make open cuts in the street except for the repair itself.

Unauthorized use of water is due either to a deliberate desire to avoid payment or to ignorance or carelessness of workmen in making a connection to an unmetered fire service or similar supply line. Such use is first apprehended in attempting a reconciliation between the results of a district measurement and those of the night subdivision tests of the district; then it can be traced down to a specific location after an inspection for leakage of the block in which it occurs. From this point it is necessary to move cautiously in order to avoid raising the suspicions of the party involved, otherwise, where dishonesty is involved, the illegal use would be discontinued until the investigators have given up the attempt to obtain evidence. Only by gradually narrowing the limits of the suspected area, and by carefully checking the flows on the services at every opportunity can adequate evidence be collected. If there is no visible service which shows the illegal consumption it may be necessary when other methods have failed, to uncover a portion of the main in search of a surreptitious connection.

Reservoir leakage, if valve arrangements and consumption permit, may sometimes be measured by shutting off inlets and outlets of the reservoir, and observing the drop in the water elevation over a given period. To insure accuracy this measurement requires careful determination of the evaporation and precipitation during the test. The actual point of leakage is often difficult to locate, since the water after escaping may travel a considerable distance underground (especially in a lined reservoir) before emerging; in some cases it disappears entirely without coming to the surface outside the reservoir.

Causes of pipe leakage

Leakage from distribution and supply mains, in the writer's opinion, generally may be laid to two principal causes—carelessness in construction, and vibration. It is true that there are cases where mains fail due to moving ground, expansion and contraction when laid on the surface, water hammer, and other causes, but these are in the minority.

Carelessness in trench excavation and laying procedure may permit pipe to rest on rock at one point, and this will probably result sooner or later in a pipe broken clean across. Large stones dropped on the pipe in backfilling may also start a crack which possibly will increase until a large piece of the pipe breaks out.

A joint securely home in the bell, properly yarned, run, and calked, should hold indefinitely without movement or leakage due to the joint material. This applies equally to joints made with lead or commercial joint compounds. Since joint failures due to blowing out of the lead accounts for the majority of main leaks, the importance of careful workmanship cannot be overstressed.

Vibration may produce the same effect as the usual joint failures and may also produce settlement resulting in bringing the pipe into contact with sharp rocks. The remedy for this is to lay the pipe deeply enough so that vibration will have no effect. Where the proximity of railroad tracks is the cause of vibration, the pipe may be run under the tracks inside a pipe of larger diameter.

The various types of service leaks are familiar to all waterworks men, and range from perforations of iron services because of corrosion, to erosion of the corporation cock due at first to a pin hole leak which impinges on the brass of the corporation unit. Perhaps the commonest service leak is to be found at the lead joint of the goose neck.

This general discussion of underground pipe leaks emphasizes that only by exercising the greatest care and competent supervision during construction can leakage troubles be minimized. Such precautions are ultimately far less costly than the losses continuing year after year caused by water disappearing underground without discovery.

Waste Water Survey Benefits Kansas City

SURVEYS for the protection and elimination of waste water have been of particular benefit in isolating areas where leakage was occurring without surface indication or other evidence of its existence, according to the annual report of the Kansas City, Mo. water department. These surveys which have been carried on for more than a year have established the fact that more than 60 per cent of all underground leakage never reaches the surface, and would go undetected for long periods of time if regular and systematic investigation were dispensed with. The elimination of waste as a result of the survey has been sufficient in amount to pay the cost of the survey and to provide an additional operating balance.

Water Main Cleaning

CLINTON INGLEE,
President, National Water Main Cleaning Company, New York

LOST carrying capacity in pipe distribution systems, resulting from mud deposits, incrustation or tuberculation, can be restored by a simple cleaning process

WATER MAINS are out of sight and generally are forgotten until an emergency fire demand indicates serious shortage of capacity, or consumers' complaints call attention to poor pressure or discoloration of the supply. The waterworks superintendent who is looking toward efficient all-around operation of his water supply facilities cannot afford, however, to overlook the distribution system. In numerous instances it has been demonstrated that inadequate supply and other distribution difficulties are traceable not so much to faulty original design, as to reduction in the carrying capacity of pipe due to mud deposits, incrustation and tuberculation.

Causes of lost capacity

There are several factors that contribute to loss of carrying capacity in water pipes. Hard waters will cause incrustation on the interior walls of pipe, but usually at a slow rate; this coating is apt to be extremely hard and difficult to remove. Excessive lime treatment will also cause incrustation—sometimes at a rapid rate. If this can be controlled the deposits will form a protective film and be beneficial rather than harmful because a light lime coating will prevent "red water" trouble and corrosion. But if the deposition is not controlled hard water may so reduce pipe capacity that cleaning soon becomes imperative.

Soft and acid type waters, by breaking down pipe coatings, act on the metal in the pipe and tuberculation takes place. With acid waters it may be but a few years when pipe capacities are so reduced as to require cleaning or replacement. It is not unusual to find 4- and 6-in. pipe reduced to one-third of its original capacity, and larger mains reduced to one-half capacity because of this tuberculation. In localities where water is of high turbidity and where mains were in service many years before filtration was adopted, deposition of sediment took place; frequently water mains are found in which one-fourth to one-half of original capacity is lost due to the combination of mud deposits and tuberculation.

Pipe capacity may be also reduced, and offensive tastes and odors caused by organic growth such as crenothrix, gallionella, etc.; this condition is not so common, however, as incrustation, tuberculation or sedimentation. Sometimes changes in treatment may be responsible, as in the case of a Midwestern plant where there was apparently no tendency toward rapid tuberculation until about five years ago when aeration was undertaken. Since then the corrosive action has been so great that water main cleaning must soon be undertaken.

Pipe cleaning economical

Whatever the cause of reduced capacity there comes a time when something must be done. New pipes can be installed, of course, but this is expensive; it involves the cost of tearing up pavements, opening long trenches, purchase of pipe, and inconvenience to consumers. The most economical and satisfactory solution to the problem is the adoption of a program of water main cleaning by which pipe can be restored to its original diameter and capacity. Even in cases where activity of the water would require periodic cleanings to maintain satisfactory capacity it will be found that interest on capital investment for replacement will more than

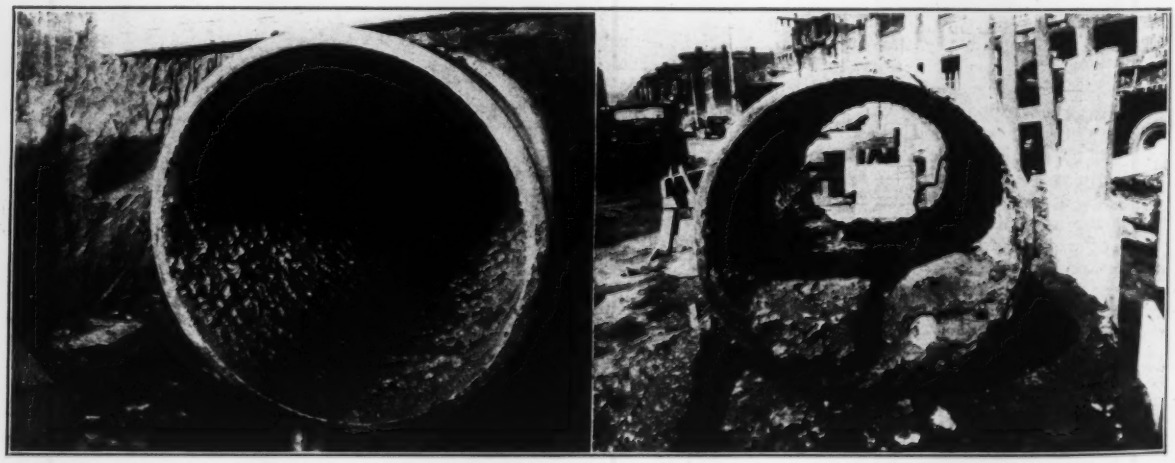


FIG. 1—CORROSION AND MUD DEPOSITION *are the principal causes of lost capacity in water mains. The examples shown above are typical of conditions existing in some large mains.*

FIG. 1—CLEANING MACHINE *emerging from riser pipe after completing a run through a 36-in. water main.*

cover the cost of mechanical cleaning. Often the saving in pumping expense alone will pay for cleaning.

This is illustrated by the experience of a small town in Maine where the supply was delivered through several miles of 6-in. main. It was necessary to use a pumping engine every night in order to fill the reservoir upon which the town relied for its reserve to take care of the daily consumption or fire protection. The cost of this pumping was $28 daily. After the supply line was cleaned its delivery was so greatly increased that the pumper was dispensed with, thereby affecting an annual saving sufficient to more than pay the cost of cleaning in a short period.

Practically all of the older cast iron water mains now in service were either uncoated or asphalt-coated when originally laid. Tar coatings give protection against corrosion for a limited time, but with certain types of water, eventually break down either partially or entirely. To overcome this difficulty cement-lined pipes are frequently used in the newer installations. Improvements in dipped or spun linings have also insured longer and useful life for cast iron pipe. Consideration of pipe cleaning in some of the newer distribution installations may therefore be indefinitely postponed.

Cleaning mains in place

The method of cleaning a water main in place involves opening the pipe in two places after the ground has been excavated down to the main so that a cleaning machine can be inserted. The distances between the pipe cuts will vary according to the size of the main, the water pressure available and the nature of the incrustation. Experience is necessary to gage these distances so that work can be economically carried on. Where there is sufficient water pressure and the condition of the interior of the water main warrants, water-propelled machines are used. It is seldom that mains 10 in. in diameter and larger cannot be cleaned by the pressure method.

After the pipe is cut the machine is inserted and the pipe is permanently made up at this end. The water is then turned on to the proper pressure and volume to give the machine the required rate of travel through the main. Best results are obtained when the machine travels at a velocity of about 50 ft. per minute.

With 4- and 6-in. mains, and also in the larger diameter pipes where water pressure machines cannot be used, a heavy cable is pased through the main by means of a special carrier and light cable or rods. The machine is then attached to the cable and inserted into the line. Following this the pipe is made up, the water turned on to the proper amount for flushing and the machine pulled through the main by means of a windlass.

With either a cable-drawn or water-propelled machine a small amount of water is allowed to pass the machine to carry ahead of it the dirt and incrustation which has been cut from the pipe and ground up by the machine. The water carrying the sediment and cleaning, is carried to the surface of the street through a riser pipe. Usually the water runs clear immediately after the machine emerges. After the machine is passed through the main the water is shut off, the riser pipe removed, the main reconnected and put in service. The entire operation requires only a few hours.

Difficulties in cleaning

In cases where mains have been allowed to go too long without cleaning or where the pipe has been poorly laid, considerable trouble is experienced. In extremely bad cases cuts have to be made in small mains as close as 400 ft. apart. Again, due to carelessness on the part of workmen when the mains were laid, lumps of lead may be found at a joint; sometimes these lumps are large enough to prevent the passage of the cleaner and this make it necessary to make an extra cut in the pipe. In some instances the valves in the line may have become closed or partly closed without the knowledge of the water officials. These naturally stop the machine and cause extra excavation and loss of time. Lack of knowledge of the condition and position of the valve may make a complete shut-off difficult until the information is secured at considerable delay and trouble. Often much valuable information regarding valve positions and conditions is secured during cleaning operations.

Mechanical cleaning properly carried out will remove all deposits, incrustation, tuberculation and growth down to the original pipe coating. It will not harm or remove any good

coating. Where the coating has not previously been disintegrated by reason of water action the pipe will be left clean and smooth after cleaning. Careful flow tests have given William & Hazen coefficients after cleaning as high as 121 on 6-in. pipe; but on small pipe coefficients of 105 to 110 are generally obtained. Variation in coefficient values are usually the result of rough interior castings and irregularities in laying. In large mains coefficients from 115 to 140, depending upon the condition of the coating and the manner in which the pipe was laid, may be expected.

The use of cement lining in large mains, while reducing the diameter slightly, will improve the pipe coefficient values and effectively overcome the necessity for recleaning. Recently, the city of Newark, N. J., rehabilitated a 48-in. riveted steel main after it had been in service 38 years. Theoretically, its useful life was over. When first laid it showed a coefficient of 110. Before cleaning in 1935 the coefficient had been reduced to 70. After cleaning this was again restored to 110; a cement lining was then applied by the centrifugal method and the coefficient increased to 124. At a fraction of the cost of replacement Newark now has a 48-in. line which will deliver more water than when first laid.

Water treatment important

Water treatment is receiving much consideration with the special objective of preventing any activity in reducing pipe capacities. Much progress has been made and, in some instances, the problem has been solved. Universal treatment panaceas cannot be hoped for but a careful study is worthwhile for each case. Periodical check-up of pipe coefficients will indicate what has taken place in the main after cleaning and treatment. Utica, N. Y. has apparently solved its problem by proper water treatment. Whereas, formerly it was necessary to clean the reservoir supply line frequently to maintain the required high capacity, now there has been no cleaning needed for a number of years.

Eventually, the technique of relining small mains after cleaning will be perfected—then with proper water treatment, water main cleaning will afford a permanent solution to all problems concerning reduced capacity in distribution systems.

Practical Maintenance Aids

ROGER W. ESTY,
Superintendent, Danvers Water Board, Danvers, Mass.

INGENIOUS schemes and useful kinks that have been developed at the Danvers waterworks to simplify general service and maintenance jobs

EVERY waterworks superintendent striving to keep his system trouble-free and keyed up to best performance must undertake a consistent program of maintenance. Although maintenance needs for one system may differ in detail from those of another, quite frequently the special kinks or ways of doing things which are developed to meet individual local requirements may have general application elsewhere. Exchange of ideas, therefore, made possible by association meetings and technical journals, are helpful in developing better and more economical methods of handling situations and problems that are common in waterworks practice.

It is with this thought in mind that the following account of experiences at the Danvers, Mass., waterworks is written. The subjects dealt with—dewatering pipe lines with compressed air, gates and hydrant maintenance, emergency repair couplings, an electric-alarm pressure gage, and the use of a rate recorder meter—are felt to be of general interest to waterworks men.

Quite frequently when making street connections, removal of water that remains in a pipe line after the shut-off is made takes more time than the actual job of cutting in the fitting. This is particularly true when the pipe is of large size, of 12 in. or more. Then, too, when the trench fills up with water there is always the hazard of side banks caving in.

In order to overcome this difficulty, the writer has successfully employed an air compressor to blow out water that remains in a pipe line. The procedure is simple: the compressor hose is attached to a hydrant or house service at the highest elevation of the line, the hydrant is opened at a lower elevation and then the air is turned on. This forces out practically all the water and at a rate much faster than that accomplished by any other means. Besides, the water can be diverted to a point where it will not interfere with excavation or repair operations.

There is no danger whatsoever to house services when the water is being forced out as the air pressure at the compressor is seldom over 40 lb. This method has been used a number of times and there has never been any difficulty. Our biggest job was to dewater 6,000 ft. of pipe, of which about 1,000 ft. was 8 in. and the remainder 6 in. in diameter. This was a dead end section and the entire line was emptied in order to cut in a street tee, several gates on the main line, as well as some on hydrant branches. It took only 35 minutes to dewater the line which was estimated to contain about 11,400 gallons of water.

The maintenance of gate valves is an important part of water distribution systems. In general, it should include periodic examinations of the opening and closing mechanism and the packing, raising the gate box to the proper grade, noting gate locations by reference marks on poles, buildings, etc., and compiling a systematic plan file of locations and measurements. Unfortunately, this is often neglected until some main blows up or a hydrant is broken and then a desperate effort is made to find the gate to close it off.

Valve inspection

At Danvers a systematic effort is made to mark the location of gates on poles and buildings or, at least, spot them on maps so that they can be quickly found. Each year an inspection is made of all trunk line gates from 12 to 20 in. and all side street gates. The inspection consists of opening and closing the valves, packing when necessary, and correcting the grade of the box cap if needed.

When these examinations were first started, some valves were found that required the combined efforts of two men to open and close them. Usually, after repacking, the gates can be operated with one finger. Improper gate

operation, in the writer's opinion, can be traced directly to faulty packing. If the mechanism has been properly constructed and inspected at the factory and a lubricated packing has been placed in the stuffing box, there should be no difficulty. Too little attention is given by manufacturers to this important feature.

Hydrant operation

Hydrants should be gone over at least once a year and given a thorough test to determine whether they operate easily and if the packing at the operating nut is in proper condition. Pressure should be put on the hydrant and the valve opened wide to determine if the waste valve closes properly and opens so that the barrel can drain. The ease of closing the valve will in most cases reveal the condition of the valve. If considerable effort is necessary to close it tight, it should be replaced with a new one. Good valves mean tight and dry valves and no winter freezing.

The nozzle caps on the hydrant should be properly lubricated with a type of grease that will not freeze in cold weather. Proper washers or gaskets should be inside of each cap in order that it will fit tight and prevent leakage. Leaky stuffing boxes can be economically repaired with a metallic packing paste.

All hydrants in the Danvers system are carefully located and referenced and this record is kept in a file card index. To aid in the location of hydrants during the wintertime when they are apt to be covered with snow, a telephone pole identification scheme has been established. On the nearest pole to each hydrant, a yellow band is painted about the same width as the diameter of the pole. On the bands are nailed black numbers indicating the distance in feet from the pole to the hydrant. This is not only helpful in the winter period but it also aids the fire department in locating hydrants quickly since these bands can be seen at a considerable distance.

Hydrants should be nicely painted for appearance sake. But they should also be quickly recognizable and therefore a paint of high visibility should be used. The matter of color is debatable. A movement is on foot to establish a national color scheme for hydrants. This is a meritorious objective and might well be carried far enough to provide for standardization of a color scheme similar to the traffic control lights, namely, green for hydrants with plenty of capacity, yellow for those with only fair capacity, and red denoting a very limited amount of water.

One of the most valuable and inexpensive waterworks materials used for maintenance and construction purposes

FIG. 1—DEWATERING *a main with compressed air showing the ejection of water from an open hydrant. The air pressure was 40 lb.*

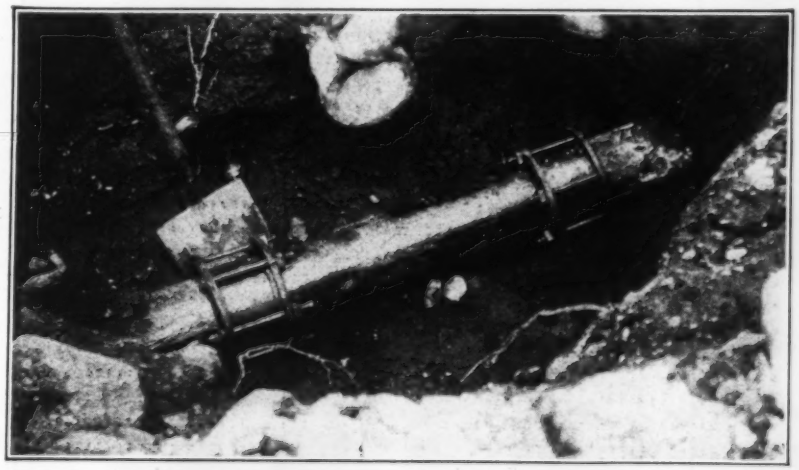


FIG. 2—REPAIR SECTION *on an old 6 in. cement lined main where a piece of cast iron pipe has been "cut in" and attached with couplings.*

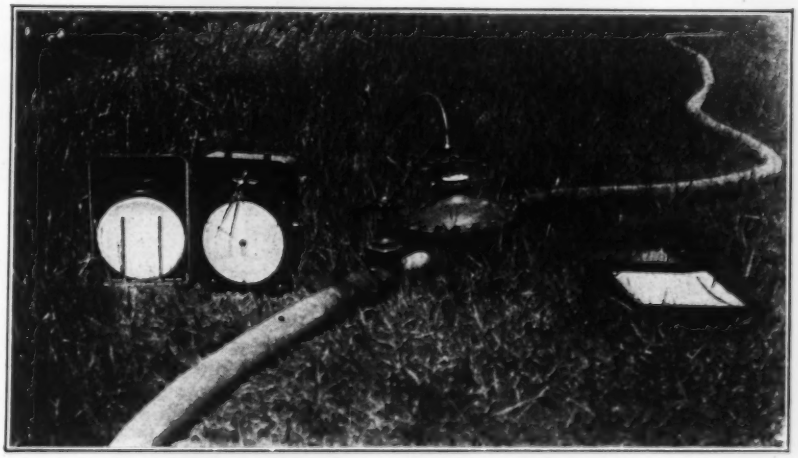


FIG. 3—RATE RECORDING *meter mechanism attached to a disk meter in order to obtain a visual record of water flow demands and variations in a section of the distribution system.*

is the coupling. Several different types are on the market but the writer is more familiar with the Dresser coupling which has been used in his department for nearly 30 years. They have been put to many uses both in laying new pipe and in repairing old mains.

In Danvers there are several hundred services that are more than a half century old. Many of these were laid in a clay soil and the metal has deteriorated to such an extent that pinholes or breaks frequently develop. To repair these by threading the pipes and fitting in a new piece is practically impossible since most of the pipe is corroded. The only thing that can be done is to dig up a section of pipe until a coupling is found. Then the entire section is taken out and another length is put back with the coupling and union.

Sometimes this cannot be done for even at the coupling a pipe may be too far gone to get the coupling off without twisting the pipe. In a situation of this kind the pipe is cut in two with a hacksaw; then the ends are sprung apart so that a sleeve can be slipped over the pipe which is then drawn together over the cut and bolted. This makes a quick, inexpensive and permanent repair. Some of these sleeves have been in use for more than 15 years and they are still good.

If a leak develops at a curb cock, the pipe can be cut about 8 in. from the connection and a new nipple of about 7 in. inserted and coupled together with the sleeve. If the leak is on the pressure side and the flow is not too great the new curb cock is cut in under pressure; the cock is left open while connecting the sleeve. This eliminates the trouble of digging down to the main and shutting off the corporation cock. After the connection is made the curb cock is shut off and then the other side is repaired in the same way.

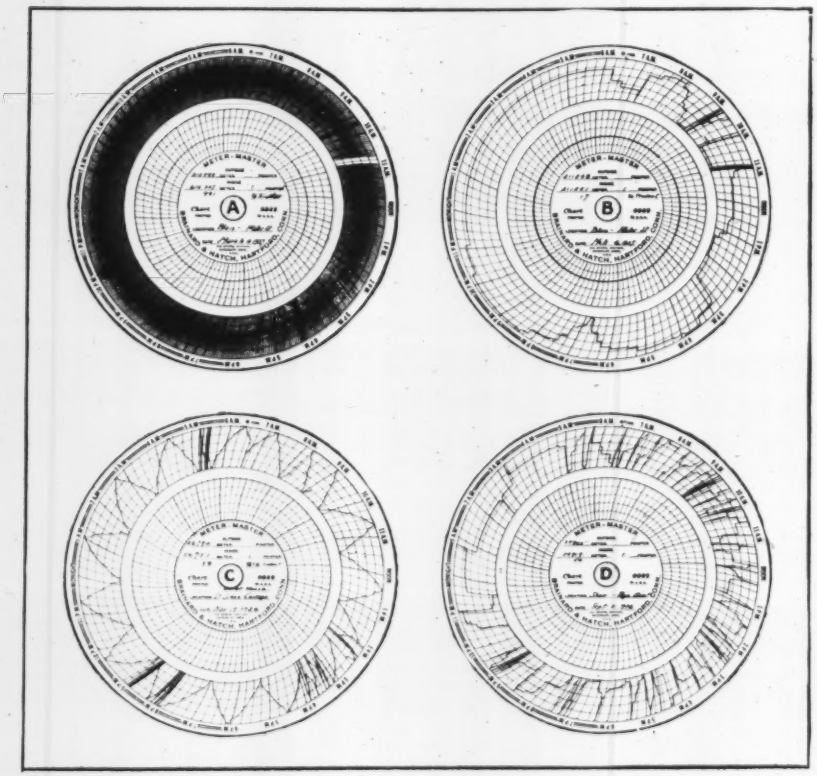


FIG. 4—CHARTS *from the rate recording meter showing (A) a leaky condition caused by a 1/8 in. hole in a 2 in. pipe; (B) the registration after the leak was repaired; (C) ordinary consumption demand and night leakage; and (D) typical recording from a single meter in a two-family house where water is used practically every hour in the day.*

Those who live outside of New England may not be familiar with the old type cement lined pipe that was laid in a great many cities and towns during the 1860's and 1870's. In those years thousands of feet of wrought sheet iron cement-lined pipe encased in cement were used. These pipes varied in length from 6 to 9 ft. They were supposed to last about 20 years, but in Danvers there are several miles of pipe that has been in the ground since 1876.

Every now and then this pipe blows up, causing a fracture from 4 to 10 in. in length. To make a repair, a piece about 2 ft. long is cut out with hammer and chisel. A piece of cast iron pipe about 1 in. shorter than the piece cut out is substituted and bolted into place with Dresser couplings. The average break can be dug out, repaired and backfilled in about six hours. Such a repair eliminates the need for cutting in a bell and spigot piece of pipe and the use of a solid sleeve. It also saves the time required in preparing jointing materials and caulking, and the work is not hindered when there is water in the trench as the repair can be made under water without great difficulty.

On several occasions gate valves have been cut in with sleeves using a spigot nipple each side of the gate about 1 ft. long. After the water is shut off, this gate can be cut in and the water turned on within an hour. A hydrant branch can be installed in the same manner by inserting nipples about 1 ft. in length on each side of a tee, connecting the tee with the main line with two sleeves. In all cases nipples have been run into the gate or tee at the shop in advance of the proposed work. These sleeves assure adequate flexibility for absorbing strains due to expansion, contraction and soil settlement that rigid joints cannot always provide and which is so important in some places.

A pressure alarm system

An electric alarm pressure gage is one of the most valuable gadgets a waterworks superintendent can add to his system. This provides an opportunity to watch or to be warned of excessive changes in pressure which usually denote that something has gone wrong in the system.

The writer has installed a separate pipe line from the street to an electric alarm pressure gage in the kitchen of his home. On the gage there is an indicator hand that can be set to close an electric circuit at a predetermined pressure below normal; in this particular case the contact point is set at 42, or 10 lb. lower than static pressure in the system. An alarm bell connected with this circuit is located in the bedroom closet of the writer's home.

If a hydrant should be broken off in such a manner as to release the gate valve and therefore allow water to gush up, there will be a sudden temporary drop in the system pressure. This is reflected on the gage which will automatically cause the bell to ring until the pressure goes up, due to the surge in the pipe line or due to the closing of the gate. The value of this device is also indicated in cases where water hammer occurs because the rise and fall of pressure associated

with this difficulty will cause the bell to ring. By checking the system immediately after the alarm has sounded the trouble can usually be located.

In one instance it was found that a laundry opening and closing a valve too quickly caused the hammer. In another case it was the opening of a 6 in. valve in a factory. On one occasion it was caused by firemen soaking a dump fire; they would open the nozzle and let it run a few minutes and then shut it off quickly and this caused just enough hammer to make the bell ring. This occurred at 2 a.m. and the writer got up to visit the factories in town and accidentally ran across the firemen at the dump fire. Should a break occur in a main the warning ring of the bell makes it possible to make all preliminary preparations so that when the exact location of the trouble is determined no time is lost in making the repair.

Fast action on a pipe break

Less than a month ago (in fact, the very night this article was proofread) the alarm gage again demonstrated its usefulness by immediately notifying the writer of a large break that had occurred in the distribution system. Because of certain repairs that were made during the day, a reservoir at higher elevation had been connected with one area of the distribution system. The excess pressure (about 8 lb. more than normal) caused an 8-in. cement-lined main, laid in 1876, to give way. When this happened in the early evening, the alarm went into action and the gage showed a serious drop in system pressure. Ten minutes later the writer had three repair trucks, fully manned, ready at the water company office waiting for a telephone call which would establish the exact location of the break. When several minutes passed by and nobody called in, it was concluded that the break had occurred in an isolated section of the town. The trucks were then dispatched to areas under suspicion and before long the broken main was found.

In all, the elapsed time between the break in the main and the appearance of the repair equipment at the location was only 35 minutes. Needless to say, this quick action minimized damage and saved many times the cost of the pressure gage alarm.

Checking water consumption

Another instrument or device that has a wide range of usefulness is a portable rate recording meter, generally known by its nickname, the "G-Man." This device can be quickly attached to a water meter and it will record on an inked chart the water that is used by the meter and at what rate it is drawn.

The recorder is operated by a clock mechanism which can be so regulated that one revolution of the chart is made either in six hours or in 24 hours. The charts are arranged with an inner and outer circle so that either the reading of a single dial meter (like an ordinary house meter) or two readings can be registered simultaneously, such as required by a compound meter. Two arms with pens and ink chambers extend out over the charts and they rotate up and down through another mechanism which is operated by a flexible cable connected with the first index hand on the meter register.

If the meter is the ordinary house type then the first index hand would register 1 cu.ft. As the meter register hand makes one complete revolution, (indicating that 1 cu.ft. of water has been drawn), the arm of the recorder makes one movement which is indicated by a stroke across the chart and back. The first index hand can also be set to register 10 cu.ft. when making one complete movement up and down. Either a 6 or 24 hour record of consumption and rate of use is shown when the chart makes a complete revolution.

In making the tests the meter cover is removed and a cap or cartridge placed over the first index hand of the register. Then a holder, fastened by cap screws, is placed on top of the meter. This holds in place the flexible cable which connects the device to the meter. If a compound meter is to be tested, then two cables are run, one to each register.

The value of the system to the waterworks superintendent is twofold —(1) to run flow tests to find out how often and at what rate water is drawn in order to determine whether the meter is too large or too small for that particular service; and (2) to check large or out of the ordinary meter bills. In the latter case it provides visual evidence of exactly how much water is being used and when, and thus gives the customer an actual picture of his consumption uses. In addition it furnishes information regarding the presence of leaking fixtures, the use of improper amounts of water by toilets, and other possible sources of waste.

The rate recorder has been used in conjunction with flow tests on large meter installations to determine when heavy demands occur and at what rate the water is drawn. With this information it is possible to determine whether or not meters are of the proper size. It is also used in connection with night flow testing of the system. In these tests the town is divided into districts and supplied through fire hose, and in most instances through a 2-in. meter. The test is generally started at 6 p.m. and carried through the night to 6 a.m. Valuable flow data can thus be obtained economically and without too much effort.

Groundwater Surveys in Cincinnati Area

A STUDY of groundwater supplies in the suburban area of Cincinnati that lies in Mill Creek Valley and the valley known as the Norwood Trough has recently been completed by the U. S. Geological Survey. For many years the water level in wells in this area has been declining gradually, but the rate of decline has been accelerated in the last year or two. The study was made in order to obtain information as to the seriousness of this decline in water level and to ascertain the type of detailed investigation required to determine the safe yield of the water-bearing beds.

The maximum decline in water level that has been reliably reported is more than 75 ft. since 1906. Observations show that geologic and hydrologic conditions differ from place to place, and that extended observations will be necessary to obtain adequate information.

Several possible reasons for the decline in the water level have been suggested. A cause commonly mentioned is the draining of the Miami and Erie canals, which occurred in 1929. The effect of the draining is believed to have been twofold: (1) industries that formerly used water from the canal shifted to groundwater, thereby increasing the draft on that supply; and (2) possible recharge of groundwater by leakage from the canal was prevented. However, information obtained during the recent investigation indicates that the effect of the drainage of the canal has been overemphasized. Other possible causes include low rainfall in recent years; a change in the regimen of the Miami River following the construction of the reservoirs of the Miami Conservancy District, which may have reduced the possibility of groundwater recharge during periods of floods; and the recent construction of a large intercepting sewer which conceivably may have facilitated and hastened the runoff of both surface and ground water. A large part of the decline in water level is due to the heavy and progressively increasing pumpage from wells.

Sound Financial Policies

THEODORE A. LEISEN
General Manager, Metropolitan Utilities District, Omaha, Neb.

GOOD management is reflected in the methods used for financing new work, maintaining equitable rates and adequate depreciation reserves

FINANCIAL policies of waterworks utilities are so generally affected by and interwoven with economics of management, that any discussion of finances is somewhat difficult without due consideration being given to the methods and results of operation. In this article, however, it will be assumed that the plants are operated efficiently in proper coordination with the fiscal program. The policies then to be considered relate to adequacy of rate structure to cover essentials of financial outlays, comparisons of types of rate schedules, methods of raising new money for extensions, the use of serial bond issues with call provisions to permit sinking fund purchases, and depreciation investments in plant betterments. Attention is first directed to those questions that concern municipally-owned waterworks.

Charging for service

Since a water department is an organization empowered to furnish, convey and sell a given commodity to the inhabitants of its community the charges for such service should be made in more or less direct proportion to the quantity consumed by each customer. With a proper rate structure the department should be self-supporting and its affairs should not be commingled with the city's tax levy either by receiving unwarranted financial support from the tax levy, or by contributing to the city's general fund out of the water revenues. Reasonable compensation for fire hydrant service should be paid by the city; this of course will be obtained through the city's tax levy and paid to the water department as a fair return for the additional expense incurred for additional pumping equipment and larger mains. Such compensation is a legitimate part of the water revenue.

Conceding that the waterworks must be self-sustaining, then the rate structure should be so devised as to produce sufficient revenue to pay all operating expense and interest on bonded indebtedness, provide adequate funds for a bond sinking-fund reserve, and a proper reserve for depreciation. In addition, provision should be made for accumulating a surplus which can be used for all ordinary extensions and routine improvements; this surplus should also be available for any emergency where quick assets are essential. All sinking-fund reserves and any accumulated surplus funds should be invested in liquid securities which can be converted into cash on short notice, but the reserve for depreciation (which in reality is a book account) can properly be utilized to pay for additions and improvements. This means re-investing the fund in the capital value of the plant, but the net amount of the reserves for depreciation should be deducted from the capital value of the plant.

The only rational method of selling water is by meter registration, so consequently discussion will be limited to meter rate schedules. Knowing the existing consumption, and with a fair conception of the quantity to be supplied for a few years in the future, it becomes a simple matter to calculate the average rate per unit of consumption which must be established to produce a revenue adequate to meet all expense of management, operation, reserves, etc. While such an average rate could not be adopted as an equitable selling price to all classes of consumers, discrimination between classes using approximately equal quantities must be strictly avoided.

Two systems of water rate schedules may be given consideration: One is based on a "service" or "readiness-to-serve" charge, and the other on a graduated scale arrangement. In the first system the charge varies with the size of meter and is based equitably, but more or less arbitrarily, on a proper proportion of all overhead and operating expenses. A uniform charge is made per unit on all water consumed or a division can be made of the unit price which provides one fixed rate for all consumption up to a predetermined quantity and lower fixed rates to wholesale users, or others using in excess of the predetermined quantity. The service charge should represent the actual standby and overhead expense involved in furnishing an adequate supply of water; the rate per unit of water furnished, however, should be based on the cost of treatment, pumpage and other incidental expenses due directly to delivering the water to consumers. This system is decidedly unpopular and has encountered general opposition where proposed.

Graduated scale rates

The other system consists of a graduated scale arrangement wherein the first bracket carrying the highest rate applies to consumers of the domestic class who use a comparatively small quantity. Other steps follow, each at lower unit rate, until the last step and lowest rate is applied to those whose use of water reaches the highest amounts. If charges of discrimination are to be avoided even the largest consumers should be charged at the lower bracket rates for the quantities designated under each respective bracket.

This rate structure probably meets the requirements of the waterworks organization (as well as the public) better than any alternative system because it is fair both to purveyor and consumer. Furthermore, it provides a method of charging for the commodity supplied in approximate ratio to the expense involved in providing it.

To clarify this point it can be shown that the expense of keeping each individual account, of reading of the meter periodically and recording the reading is virtually the same for the smallest consumer's account as it is for the largest. Furthermore, the cost of management and all overhead expense differs little by reason of the quantity of water passing through the meter. The only item of expense which varies in direct proportion to the quantity of water consumed is the cost of production. Obviously then an industry using a large volume of water is frequently more profitable at the lower rate than the average domestic consumer at the higher rate. Another factor which makes it essential to provide the lowest possible rates for industries is that in many instances such establishments will de-

velop an independent supply unless the rates for the public supply are favorable. The resulting loss of consumption and revenue to the waterworks means higher rates to smaller consumers.

In connection with the schedule it is highly desirable, if not essential, that a small minimum charge be made for every connected meter to cover the cost of water up to the amount of that charge. It should be exacted when a lesser quantity or no water at all passes the meter, for as long as the service is on, ready for use, a certain expense is involved. The minimum charge should be sufficient to compensate for this expense.

FIG. 1—OMAHA WATER COMPANY OFFICIALS *ready to burn half a million dollars worth of bonds which were paid off before maturity. Mr. Leisen is holding an armful of "fuel."*

Manifestly no suggestion can be offered as to rates to be charged nor as to the number of brackets to be used or the quantity allowable under each bracket. This is a problem which must be solved by the management of each individual waterworks. The amount of revenue required must govern the rates, but the character and scope of the different brackets in the schedule will be influenced by the nature or type of the community's industries.

Financing new work

Owing to the partial moratorium in construction and development work since the early stages of the depression, there exists the possibility that many needed improvements and extensions will soon be projected. In order to finance this new work it may be necessary to revise rate schedules. Further, the increasing cost of labor and materials may also necessitate higher rates.

With the exception of PWA projects or those prosecuted with labor furnished by WPA, there has been comparatively little waterworks development in recent years. In consequence, it is reasonable to assume that those plants that have not kept up with, or ahead of, present requirements may find it necessary to inaugurate major construction programs. Special financing may be required to meet the contemplated obligations. Also, where a new waterworks is projected or where a municipality purchases an existing waterworks from a privately-owned company a similar condition will prevail. Air-conditioning requirements loom large in the offing and this may result in an unanticipated demand for water and necessitate increased plant facilities.

To raise the necessary funds in any of these cases a bond issue equal to the estimated cost involved should be arranged for, unless there exists some law or ordinance prohibiting such procedure. No trouble should be experienced in disposing of the bonds under present market conditions, providing the data extant demonstrates that the revenues to be received will be ample to meet the costs of operation and interest and sinking fund charges.

If the proposed bond issue is to finance additions to an existing plant which now has no outstanding bonded indebtedness the situation is greatly simplified. If it is to supplement an existing bond issue care should be taken to set the maturity date of the new issue so as not to conflict with the financial arrangements that govern the former one. If the sinking fund for the old bonds is ample, there should be no particular difficulties in floating the new issue of bonds.

In the case of an entirely new waterworks, the bond issue should be ample to cover the total estimated cost. If an existing plant is purchased the bond issue proceeds should cover the price plus any additional amount that might be required for immediate improvements or additions.

Bond retirement

Throughout this discussion on bonds it has been contemplated that every issue would be paid off at maturity and not be refunded. It would seem preferable to stagger the maturity dates, dividing the issue so that the bonds would mature in separate groups, at five or ten year intervals. In every instance a call provision should be incorporated so that any accumulation of surplus funds could be utilized in the purchase of these bonds on call dates.

The tendency to provide only for payment of interest on outstanding bonds with the expectation of refunding at maturity has been too prevalent in the past. This practice should be discouraged. Instead, a sinking fund plan should be set up immediately upon issuing bonds to provide for their payment at maturity. For this purpose an amount should be reserved each year which, with interest compounded annually for the life of the bond issue, will at maturity date equal the par value of the bonds. These funds should be retained intact religiously. With a properly devised rate schedule this procedure will be found entirely feasible.

Any system of waterworks accounting should include a reserve for depreciation. This reserve need not be maintained in marketable securities, but may be re-invested in the plant in the form of payments for betterments. Replacement or repairs that tend to bring the affected equipment or appliance back to normal value may properly have their costs charged against the depreciation fund.

Depreciation rates

The rate of depreciation on the several items entering into a complete waterworks system will vary radically but for practical purposes it will suffice to adopt an average rate on the total value of the works. In a careful analysis of one plant where the depreciation rate for each component part was based on the estimated useful life of each item, the average for the entire plant was 1¾ per cent. It is fair to assume that a rate of from 1½ to 2½ per cent should be ample in most instances. If the original plant was not designed with a view to meeting demands of future expansion, obsolescence may tend to demonstrate the necessity for a higher rate.

Many waterworks officials question

the propriety of making the waterworks assume both the burden of the sinking fund and the depreciation charges. They contend that if the plant was financed by a bond issue and those bonds are all redeemed a second fund should not be required to pay for it again. Theoretically there is some merit to the contention, but practically it seems wise to provide the depreciation reserve if used in the manner described above.

Where it is permissible to do so, the financing of new water mains may be greatly facilitated by assessing the abutting property on the theory that the property is directly benefitted to an extent equal to or greater than the amount of assessment. This arrangement applies with especial force where new subdivisions are being developed. The assessed cost should be limited to the cost of a 6-in. main, regardless of the size of main actually laid. For the convenience of the real estate owners the assessment can be spread over a period of years, subject to interest chargs on unpaid balances.

Private water companies

Much of this text might apply in a modified degree to privately owned waterworks but some of the suggestions on financing methods probably would not conform to the commercial requirements of the private corporation. Usually the private plant is a stock company and the stockholders are entitled to a reasonable return on their investment. Payment of dividends is more desirable than accumulation of funds for redemption of bonds at maturity, hence refunding of bonds is customary. For the same reason the company might not find it expedient to amass a large amount of surplus funds to finance future additions and extensions, especially if the internal revenue law penalizes such procedure.

In preparing its rate schedule the private company must take into account taxes and dividends in addition to all other expenses common to both private and municipal plants. For valid reasons it may prefer to retain its outstanding bonded indebtedness indefinitely through repeated refunding, rather than burden the water rate with the additional item required for the bond sinking fund. This is logical but wrong.

Customer Accounting

HAL F. SMITH
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ACCOUNTING and billing procedure should not only furnish complete statistical data but must also include a system of controls that guarantee accuracy

CUSTOMER ACCOUNTING has been unpopular from the beginning because it dispelled the pleasing belief that water was as free as the air, but it was adopted as a necessary evil and has been treated as a stepchild ever since. It it any wonder then that the practice of customer accounting and related activities have failed to keep pace with advances in the engineering and purification divisions of the water-supply industry? Or is it surprising that although many waterworks officials know that each cubic centimeter of raw water delivered to the purification works between the hours of four and five on the afternoon of Oct. 21, carried 1,453,246 invisible bugs, they frequently do not know within thousands of dollars how much their customers owe them for services rendered or how much of their outstanding balance is past due?

In recent years, however, customer accounting practice has been making forward strides. Because of the general demand for better customer accounting methods there is now available a choice of three efficient, economical and fundamentally sound accounting systems; i.e., (1) the stub plan, (2) the register sheet plan and (3) the combination bill-and-ledger accounting plan.

What a system provides

Space does not permit a discussion of the relative merits of these three plans but it is sufficient to say that all of them are good. They are not foolproof, however, and no system will give satisfactory results without intelligent direction and coordinated, conscientious attention.

What should be expected of a modern customer accounting system? In brief, it should:

Produce an accurate, neat and easily readable customer's bill and ledger record.

Provide for proof that all indicated consumption is billed.

Provide for proof that the established rate has been accurately applied to indicated consumption.

Provide for proof that all unpaid balances have been carried forward as arrears to the customer's bill.

Provide for proof that all sundry charges have been posted to the ledger record and the customer's bill.

Provide a ledger record whose every item can be easily and promptly traced to its original source.

Provide proof that all receipted coupons as received from the cashier are credited to the customer's ledger.

Provide proof that no unauthorized debit or credit has been posted to the customer's ledger.

Provide for controlling accounts and statistical records that will make a prompt and accurate answer possible to any reasonable questions that may be asked, as for example:

(a) What was the outstanding balance in District 22 yesterday and the balance on the corresponding day a year ago? What per cent is this of the total outstanding balance?

(b) What was the total delinquent balance yesterday and how does it compare with the delinquencies a year ago?

(c) What was the average daily consumption last year for services covered by $\frac{3}{4}$ in. meters?

(d) How much water did we sell last year at the first (rate) step, the second step and the third?

(e) What was our revenue from service charges last year?

(f) How many minimum bills were average rate charged per thousand rendered last year and what was the cubic feet for actual consumption within the minimum bill allowance?

(g) What per cent of total pumpage is revenue producing?

(h) What per cent of total pumpage last year was delivered to domestic consumers, commercial consumers and to industrial consumers?

(i) How much water did we furnish gratis to charitable and to municipal institutions?

Any properly operated modern customer accounting system will provide prompt and accurate answers to these and similar questions. And

these statistics are gathered at practically no additional expense since most of them are obtained as a by-product of the billing-proof operation, or in other words, from the breakdown of the abstract sheet. Nearly all of the statistical information that is not obtained directly from the abstract sheet can be obtained by simple calculations, based on figures obtained from the abstract sheet.

The element of control

Thus far the word "control" has not been emphasized. In the writer's opinion it is the most important word in this article. What does it mean as applied to customer accounting? Simply stated it means a system of summarizing all debit and credit items posted to the individual customers accounts, posting the totals thus obtained to a controlling account, and periodically balancing the controlling account with the individual customers' accounts as a means of proving the mathematical accuracy of all bookkeeping operations.

In a water department of 300,000 accounts, with operation of a customer accounting system on the cycle plan and thus billing accounts quarterly, there are approximately 12,000 entries made each day. It is evident, therefore, that we cannot apply a mathematical proof to the entire 300,000 accounts at one time, so we break them down into units—controlling units. Two important points should be kept in mind when selecting such a unit; i.e. (1) It should be a natural subdivision, and (2) It should contain not more than 500 accounts, and preferably less.

The number of accounts in a unit depends to some extent on how many adjusting entries are made to the ledger, the kind of penalty or discount plan in use, and the quality of supervision. (In Detroit 300 accounts are included in a unit). Naturally, the fewer number of accounts in a controlling unit, the easier it is to locate errors—and there will be errors.

A brief descripition of the Detroit Water Department customer accounting plan will illustrate what is meant by control.

Accounts are billed quarterly, except those covered by meters 4 in. and larger, which are billed monthly. For the purpose of reading and billing the quarterly accounts, which are more than 99 per cent of the total, the city is divided into 36 districts; this permits a little less than two days for the reading of each district. The system is operated on a cycle plan, and the schedule provides a period of two days for the completion of each operation for each district. These operations include reading meters, checking readings obtained and entering skipped readings, preparing bills, proving computations, delivering bills and all of the various duties that make up the collection routine. Under this plan all operations are in progress every day, thus assuring an even flow of work and eliminating peak loads at any point.

FIG. 1—BILLING MACHINES *expedite the handling of customer accounts and produce neat, accurate records. The Detroit office is well lighted and the ceiling is sound-proofed to reduce noise.*

Billing—The customer accounting system used is the combination bill-and-ledger plan. Public utility billing machines are used and are so designed as to print the bill and at the same time make a carbon impression of the bill on a proof (abstract) sheet and then, by a repeat-print operation, to post the same items to the ledger card, thus assuring that the items posted to the bill proof sheet and ledger card are identical (Fig. 2).

Cash posting—Water bills may be paid at the main office of the department or to any of the sub-agents of the American Express Co. with whom this department has a contract. This latter procedure has established 500 neighborhood collection agencies scattered throughout the Detroit district. All payments received on any given day, including returns by the agents, are posted to the customers' ledgers the following day. This is made possible by running a night force of clerks who receive all cash stubs that are paid during the day. These clerks sort the stubs to ledger order, pulling ledger cards from the inactive districts and running a recapitulation tape of the cash stubs to balance with the cashier's total and to establish a pre-determined total for each controlling unit. The stubs are therefore all ready for posting the following morning. Cash posting machines post cash to the ledger cards in red figures and run a tape showing transfer totals for each controlling unit and a grand total for each district. The operator checks the control totals with the predetermined totals as work progresses. At the end of the day there is no question as to the balance for the simple reason that each operator has been in balance all day. The recapitulation tape is checked with the cash posting machine tape and sent to the internal audit and control division for entry to the controlling accounts.

Audit and Control—It is generally agreed that a customer accounting system which is not under complete control and in balance both internally and with the general ledger cannot be considered satisfactory, no matter how well it otherwise appears to be operating. The control ledger is entrusted to a senior clerk who acts as control keeper. A master control consisting of 40 controlling accounts, one for each of the 36 districts and four extra for other divisions peculiar to this department, is maintained. This ledger is arranged to show a daily revenue distribution, cash receipts and balance outstanding. It serves, therefore, as a daily summary of all entries made to customers' accounts. A mathematical proof of control entry has been worked out and is applied daily; this is an assurance that entries are made in the correct amounts and to the proper accounts.

Each of the district controlling accounts represents about 7,500 customers' accounts. This is too many for balancing purposes, so a control has been set up for each reading route, consisting of 170 accounts. Since there are at present 1,756 reading routes, it means that there are 1,756 of these sub-controlling accounts, known as route controls. To these controls are

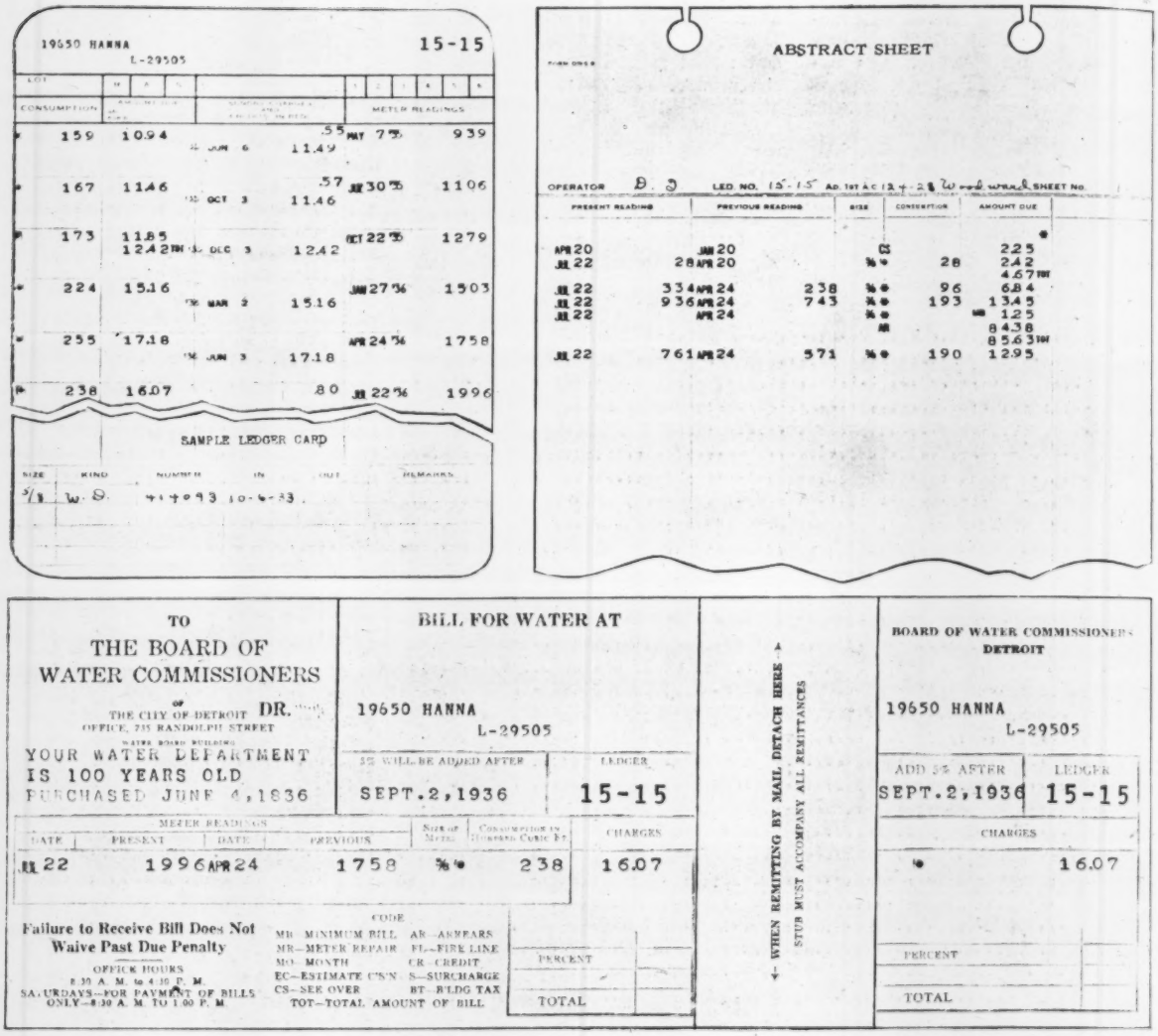

FIG. 2—ACCOUNTING AND BILLING *forms used by the Detroit water department are neat in layout and contain all essential data for accurate statistical records.*

entered only the balance at the last balancing date and the total daily debit and credit items. If this control is accurately kept, it will show balance outstanding in the coresponding route for any given date. If it were known that no error would ever be made to either control or ledger card, trial balances would be unnecessary, but in spite of all precautions taken to prevent it, errors will occur. A periodical trial balance is therefore essential.

Trial Balance—Running a trial balance of customers' accounts is often considered a difficult and expensive operation; formerly it was thus in Detroit. Present practice, however, makes this one of the simplest of operations. All unpaid balances are posted to the current bill, hence to the abstract sheet. The sum of the individual balances for the route is then the outstanding at that time and should check with the control. If it does not, only 170 accounts need checking. The error is found in a few minutes, corrected and the controlling account is balanced. The small control unit and the cycle plan of balancing have made this possible. The route controls are kept in balance with the master control which, in turn, is kept in balance with the general ledger by means of periodic checks.

A sure method of check

If there is any question as to whether or not the customer accounting system is under control, this experiment is convincing. Select a ledger card from a district that is just about ready to be billed and without the knowledge of any other person, post to it in the regular manner a credit item, say of $2.42 (as cash received) and place the card back in file (keeping a memorandum of the entry just in case the experiment does not work). If the system is under control, it will not be long before the control clerk is addressing his superior in some such manner as this: "Well, Chief, it looks like I've got something this time. Here is a card with a fake credit posting of $2.42 on it." How did he discover it? Well, like this:

When checking the arrears balance as taken from the abstract shown on the corresponding controlling account, he noted that it was out of balance by $2.42. He quickly checked the individual ledger cards, covered by this controlling account and found that the sum of cash posted to the ledger cards was $2.42 more than posted to the controlling account. He then checked cash entries by dates and found the exact date on which $2.42 more was posted to the ledger card than to the control. He then looked

through the cards and found only one $2.42 posting on that day. Next, he went to the paid stub file and checked the stubs of that day for this particular controlling unit and found that there was no stub in the file for this posting. To make absolutely sure that it was not simply a question of the stub being misfiled, he checked the cashier's tape and found that there were three $2.42 payments made that day. He then checked the cash posting recapitulation tape to locate these three $2.42 items, checked the stubs with the ledger cards, found them to be correctly posted to the proper accounts, thus proving that the $2.42 item was posted without authority.

If the experiment works out as stated above, you may be reasonably sure that your customer accounting system is under control, but if your control fails to catch this item, something should be done.

When the Customer Complains

LEON A. SMITH
Superintendent, Water Department, Madison, Wis.

PLEASANT public relations call for the exercise of diplomacy in handling the usual—and unusual—complaints and requests that come to the office

WHEN considering the matter of water utility complaints and what to do about them, it seems proper to discuss the subject from the psychological angle before mention is made of the various ways and means of handling complaints. Individuals have different viewpoints and personalities and for that reason the utility employes who handle complaints must be carefully selected for quick adaptability to situations because there are no rules which apply in all cases.

When a loud-voiced kicker comes to the office, it is better to let him blow off all of his steam before attempting to apply quiet logic. Customer abuse should be ignored. It takes two to make a fight and if the utility employe listens respectfully to the complaint, the kicker will quiet down and the matter can then be discussed properly; as a matter of fact, a point is reached when the complainant begins to feel sheepish and then the utility employe has the advantage. Ordinarily, when complaints are received over the telephone it is better to send an inspector to the premises to discuss the matter personally rather than attempt to do this over the telephone.

Complaints should be separated carefully from requests for information or for service. One of the best ways to handle complaints is to anticipate them. In water utilities probably the largest number of complaints are registered in connection with bills. Anticipating these complaints the following procedure has been adopted in Madison.

Water bills are rendered semi-annually, but the meters are read at least three times during each six months period, and more often in the case of large consumers. When a meter reader finds abnormal consumption he reports this fact to the office. A letter is then written to the property owner notifying him of this fact and suggesting that a plumber inspect the water fixtures and make the necessary repairs. The letter points out that this is advisable in order to prevent further waste of water and the abnormally large bill which will otherwise follow. A copy of this letter is filed so that when the bill is rendered and the customer comes in to complain a record of the facts will be available. Free inspection of house plumbing systems is made by the water department at the request of the property owner or the tenant.

Abnormal water bills may be due to leakage through defective plumbing fixtures, an increase in the use of water, an erroneous reading of the meter or an inaccurate registration of the meter.

Few errors occur in reading meters, and meters which register in favor of the utility are seldom found so that in most cases the cause of a large bill is leakage of water through defective plumbing fixtures or an increase in the use of water. However, the customer invariably feels that the meter has been erroneously read or that the meter is inaccurate. In a large majority of cases abnormal bills are due to leakage, principally through defective toilets. If the customer insists that the meter must have been read wrong an inspector is sent out to make

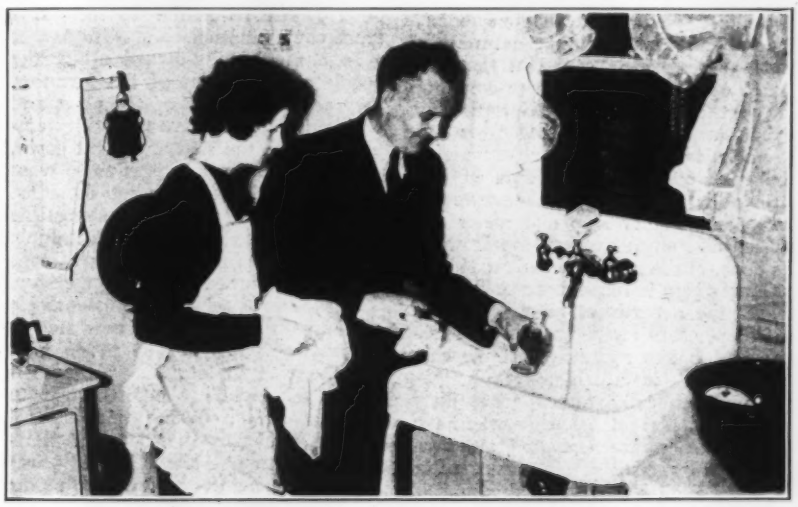

FIG. 1—A CONSUMER WHO *questioned the purity of the water is an interested eye-witness to the collection of a sample which will be sent to the local board of health for analysis. A detailed report from the laboratory is forwarded to the consumer within a few days.*

a check reading. If the reading is found to be correct it is suggested that the meter be tested. Madison regulations provide that a meter will be tested without charge if it has not been checked within five years. If it has been tested in this period the customer is required to make a deposit to cover the cost of the test, which is returned to him if the meter is found to be off more than 2 per cent.

In Madison the utility owns the meters and maintains them without charge except when they are damaged by frost, by hot water backing up into them or by external violence. A considerable number of complaints with reference to bills are due to the charges which are made for repairing meters which have been damaged as stated.

These complaints are generally easy to adjust since the broken frost bottom, or the warped disc is retained and is available for the customer's inspection. In the water department office a water meter with glass windows has been connected with water service so that the customers can see the meter in operation. In addition two meters are shown partially cut out so that their operation can be explained. A complete toilet mechanism is available by which it is possible to explain the causes of toilet leaks.

Service complaints

Another group of complaints has to do with service—such as poor pressure, dirty water, water hammer, taste, odors and items of that nature. In some cases people complain that the family has become ill due to drinking city water. These complaints usually come in by telephone and it is extremely important that an inspector be sent out the same day. If the trouble is caused by poor pressure the curb stop, meter stop and meter are tested and any necessary repair work is done. If the service pipe is too small a larger pipe is recommended. In such cases the department allows a credit of 50 per cent of the cost of the service replaced to apply against the cost of the new installation.

Little difficulty arises from dirty water except in the spring when the street flushers are first used, although occasionally dirty water occurs after a large fire. Whenever a hydrant is used, either by the street or fire departments, velocities in the main increase with the result that any rust or sediment in the main may be drawn into the house service. The remedy for this situation is flushing the hydrant, preferably where the person complaining can see that this is being done. In some cases the service also should be flushed out by disconnecting the meter and running a hose through a window. Water hammer is generally localized within the home and is due either to the air chambers becoming filled with water, a frayed faucet washer or defective toilet packing. In such cases the water is shut off and the plumbing fixtures drained, after which the water is turned on and the air chambers are filled with air. A frayed faucet washer or a toilet packing is either replaced by the water department, or the property owner is advised to have his plumber make the necessary repairs. No charge is made by the water department for this service.

Taste troubles and illness

The water in Madison comes from deep wells and the only treatment it receives is chlorination. The only taste troubles possible are due to overchlorination or to the taste which occurs from the bituminous coating on the interior of newly-installed pipe. Both of these complaints can be remedied by flushing.

Occasionally a family becomes ill and concludes that it is due to the water supply. Some physicians even suggest that the water may be the cause. In these cases an inspector is sent to obtain a sample of the water to take to the laboratory of the city Board of Health for analysis. A report is furnished directly to the customer by the laboratory. A residual of free chlorine is carried in the water and therefore the chemist can demonstrate to the physician (by means of an ortho-tolodin test) that chlorine is present, which is pretty good evidence that the water is free from contamination.

In a municipally-owned utility the people are conscious of the fact that they are the owners of the plant and seldom hesitate to give the utility employes, from the superintendent down, rather specific instructions as to what they should or should not do. One of the common complaints along this line is that men are loafing on the job. For instance, in repairing curb stops a man is assigned to dig up the stop. The pipe is then frozen just outside of the stop to permit the new stop to be inserted. It takes 30 to 45 min. for the pipe to freeze. Of course it is not worthwhile to take the man to some other job during this interval so that he usually sits there and waits for it to freeze. This "idleness" offers many citizens an opportunity to report to the superintendent that the man is not doing his work. Men who are engaged on this work are now told to get out of sight and to stay out of sight until the service is frozen and ready for further work.

Handling emergency calls

Water utilities must give 24-hour service and demands for service may occur during the night or on Sundays or holidays so that it is essential that there be someone on duty continuously with a truck to answer service calls. Two men are on duty with a truck up until midnight and one man thereafter until morning. Service calls at these times are generally due to some condition which arises in the home or to damage to automobiles from improperly protected construction work.

When a pipe breaks in a house in many cases the customer is unable to shut off the water. Prompt attention is necessary if the damage is to be kept to a minimum. Last winter a woman who lived two miles from the service building called and said to come at once because something was wrong. The service man found that the woman was alone in the house, sleeping on the first floor, although the bathroom was on the second floor. Inadvertently, she had left the water running with the plug in the lavatory bowl with the result that when she came downstairs and went to bed the bowl overflowed. Finally the water worked itself through the floor and plaster and was dropping on her bed. This, of course, made her certain that there was a water leak. The truth of the matter was that she was afraid to go up to see for herself what was wrong, so that the service man took a 4-mi. drive on a cold night merely for the purpose of pulling the plug out of the lavatory bowl.

Sometimes automobiles become mired in soft ditches or are damaged by running into pavement cuts which are not adequately lighted. The service truck has the necessary towing equipment to assist people in such difficulties. A stock of cinders and gravel is kept on hand for emergency filling of soft ditches. It is difficult to keep lanterns on pavement cuts in the university district during the football season, especially on a night before a big game. The colors of the University of Wisconsin are cardinal and white. The lantern globes are red and it seems logical to the students, in the interest of an appropriate celebration, to use these lanterns in their parades and bonfire activites. The night crew simply replaces the "borrowed" lanterns which are nearly always returned.

Analysis of complaints

About 2 per cent of the customers complain most of the time. If their present water bill is larger than the preceding bill they want to know why. If it is smaller they want to know why the last bill was so large. They are called "Two Percenters", and while it is recognized that they must be treated politely they must also be handled firmly. No special consideration should be given at any time because if this is done once it is expected on every occasion. A person handling these complaints should be of an even disposition and well poised as he must stand a lot of abuse with-

out argument. At times he must apologize profusely for things for which neither he nor the utility is responsible.

A large number of miscellaneous complaints must be handled individually. For instance a customer calls up and says that something is missing from the basement or that the meter reader has been drinking some of his fine old wine which is stored in the basement. Every possible effort is made to hire meter readers who can be relied upon and if it is felt that these complaints are justified a new meter reader is assigned to the work. Occasionally someone calls up and says that one of the employes has insulted his wife. In this class of complaint it is best to assume his story to be true and to make apologies, even though the facts do not indicate any cause for complaint.

When services are installed or repaired, pavement cuts must necessarily be made which should be allowed to settle for some little time before making the permanent repair if a good job is to be done. When people call up about such a condition we attempt to make the repair promptly. When service boxes are repaired we find it advisable to seed the lawns, top dress them in the vicinity of the work and even sod them.

Three little words

Three words should never be used in dealing with a customer. One is the word "penalty"; to avoid its use "gross" and "net" bills should be mentioned. Another is the word "must." The customer should never be told he "must" or "must not" do something. The third is the word "doesn't"; never say that the utility "doesn't do this," or "doesn't do that," but rather state in the affirmative what the utility actually does.

Quite often a person explains that he overlooked paying the bill and wants approval so that he need pay the net amount. If the record of this customer is clear he is permitted to pay the net amount after the final discount date once in every ten payments. Generally, the customer who makes this request is almost always late and the gross amount must be paid. It is important to be positive in speaking with a customer—an employe should never speak apologetically with reference to the regulations, but should state firmly and politely that rules cannot be broken under any circumstances.

Quite a few rather humorous complaints arise, some of which require special action. Not long ago a person came in with a water bill of $3.58. The bill for the previous six months was $3.50. I didn't see why a person should complain so vigorously as this chap did about an 8c. increase. He said "you don't know the half of it—six months ago my mother-in-law lived with us and the old lady took a bath every single week. She has been gone for six months and you still insist I used 8c. more water." Under conditions of this kind it is obviously better to reduce the bill 8c.

Our water supply is rather hard, having 18 to 20 gr. per gal. of hardness. About a year ago a woman called up and asked where she should send the bill. I asked her to what bill she referred and she said the doctor bill and hospital bill for her son who had had some gallstones removed. I asked her if the doctor had made a statement that the stones were due to hard water and she said no but that the neighbors had.

From the 14,000 water customers in the city about 800 complaints are received each year, which is less than 6 per cent. If each of these complaints were made in rotation it would take 17 years before any individual customer complained the second time. The viewpoint of the customer toward his water company will be governed largely by the consideration he receives in matters of service, so that it is quite obvious that complaints must be handled with a good deal of care and consideration. Regulations are splendid but sometimes they lack flexibility. There should be no hesitancy in overlooking regulations if by such procedure fairness and justice are better served.

FIG. 1—IRRITATED *by a large water bill, this customer comes to the office to fight it out and thus gets his first lesson in eliminating the principle cause of abnormal consumption—leaking toilet fixtures.*

Economical Treatment of Paper-Mill Waste

THE common method of disposing of paper-mill wastes is to dump them into nearby streams. However, these wastes are objectionable because they have a high oxygen consuming capacity and are deadly to aquatic life. In addition, they cause an objectionable color and are of such a nature that subsequent treatment of river water is difficult and expensive.

A method has been developed which removes most of the objectionable constituents of the paper-mill waste and produces an effluent which can be discharged safely into either sewers or streams. This was described by H. B. Riffenburg and W. W. Allison, of the Virginia Polytechnic Institute, at the American Chemical Society meeting on April 13. Briefly, the method of treatment consists of adding calcium chloride to the black liquor and nearly saturating the mixture with flue gas (CO_2) which gives the solution a pH value of about 6.0. The mixture is thoroughly agitated and calcium hydroxide is added until a basic reaction to phenolphthalein is obtained. Following another period of agitation, the precipitates are allowed to settle and the effluent is drawn off. The flue gas and calcium hydroxide treatment is repeated on the effluent twice. This produces a solution which is nearly clear with 90-95 per cent of the organic matter and color removed and an equal reduction in biochemical oxygen demand. The solids which are precipitated may be burned and the lime removed.

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June 3, 1937

A More Readable Paper

BEGINNING with next week's issue *Engineering News-Record* will appear in new typography and with rearranged contents. Both changes have been planned to make the paper easier and more convenient to read. The new type was selected for its readability, and one of America's foremost typographers has so utilized it that the essential message of the page may be most easily grasped. The rearrangement of contents was likewise fitted to the reader's needs. The week's news, which today demands first attention, opens the issue. It includes in prominent position a summary of the current facts on construction activity—contract awards, price and wage changes and the like—in recognition of the commanding importance of construction advance as the final step in the return from depression. Discussion of current questions, which plays an increasing part in molding engineering opinion, follows next after news, and in turn is followed by editorials and articles, each arranged for convenience in reading and use. Two pages of contract unit prices, so placed as to permit clipping and filing, appear in each week's issue except the first of the month, where they are replaced by market quotations of construction materials and labor. New equipment to aid the constructor and news of the manufacturers have also been arranged for filing. Construction reports are segregated in a special tinted-paper section for the convenience of regular users. The structure of the paper throughout is designed to save the reader's time and effort. The editors hope that the new arrangement will meet approval, and they will value comment pro or con as a guide to further improvement.

The Larger Task

WITH ITS CHANGE IN OUTWARD APPEARANCE—*Engineering News-Record* is also strengthened in contents. To meet the modern world's increasing requirements the engineering construction profession needs an information service of greatest possible breadth and thoroughness. The demands on the profession and its industries are far greater than ten years ago, will increase further. The engineer's technique must be surer and more highly specialized, and yet the specialist must be in closer touch than ever before with other branches of the art and their scientific progress. Even beyond this, modern conditions make it necessary that engineering performance be adjusted to economic and social requirements, that its financial relations be sound and clear, and that public understanding and support of construction activities be at all times maintained. The days when the engineer could confine his interests to the technique of his art are definitely behind us, and for future effectiveness in community service his equipment and also his current information must rest on a broader base than heretofore. It will be the aim of the editors to shape the paper's service to these needs. They confidently look forward to the same aid and cooperation from their readers in this larger and more exacting task that they have enjoyed in the past.

Just Another Bridge?

LAST THURSDAY men walked and rode across San Francisco's Golden Gate for the first time, as the big bridge was opened around which have ventured as many human tempests as gales from the Pacific. Just another bridge, the cynic may say; its accomplishment called for nothing much beyond routine application of what bridge engineers have learned in their construction of the last dozen years or for that matter an entire generation. But he would be wrong. A great work has been accomplished in the completion of the Golden Gate Bridge. Once more the bounds of what man can do have been pushed forward, establishing a new base for further progress. Together with the other and no less imposing roadway that has been thrown across the Bay to the east shore, the Golden Gate Bridge stands as a symbol of the long way that bridge engineering art has advanced during three-fourths of a century in overcoming the barriers of space. Those who built the structure at San Francisco stood on the shoulders of the bridgebuilders who went before, and what they now have wrought will in due time become the starting point for further progress—just as the far-famed Brooklyn Bridge, despite its now puny proportions, was the work that made possible the three great spans that cross the Hudson River, San Francisco Bay and the Golden Gate.

Art Is Long

BECAUSE THE BROOKLYN BRIDGE achievement of 53 years ago prepared for the grander accomplishments of bridge construction of current years, there is meaning in the fact that the work of the '80s is linked to the bridge just completed by a direct line of succession of human endeavor. John A. Roebling, suspension bridge pioneer, made the Brooklyn Bridge possible; his direct successors in tradition, knowledge and spirit played a determining part in building Golden Gate. We see before us an instance of that continuity of effort which—be it called experience or tradition or accumulated skill—plays an unmistakable part in the progress of the arts. More is at issue than the mere survival of shop craft, or of name, or of commercial acumen. The basic restudy of suspension bridge problems that is made evident by the emphatic advance of cable erection performance at Golden Gate tells of the survival of some of the same spirit that the elder Roebling built into his great span across the East River. It is fair to conclude that virile tradition has a value that we cannot afford to neglect—though such tradition of course can never remain virile unless recreated every day by the same kind of effort and idealism as that of its founders.

Poor Witnesses

ENGINEERS ARE AT THEIR WORST on the witness stand, according to Frederick Stuart Greene, New York State superintendent of public works. In their desire to be absolutely accurate they hesitate and hem and haw, thus giving the impression that they don't know their stuff. Further, big six-footers let a little runt of a lawyer

scare the wits out of them. Col. Greene's remarks were made at the recent annual meeting of the New York State Society of Professional Engineers. By coincidence the newspapers of the following day carried an announcement that at the Rensselaer Polytechnic Institute student engineers are being put to cross-examination by their fellows as part of their regular training. Other engineering schools could well follow the example set by R.P.I., for, as Col. Greene so aptly points out, the very men who should make a favorable impression on a jury and who should be able to present facts clearly often succeed in doing neither. One reason for this is unfamiliarity with court procedure. As courts are in session frequently in every town of any size, engineers could help to correct this situation by taking time to go to court to observe how witneses are handled and to learn what is expected of them.

Better Service for Less Money

EFFICIENCY and economy are nowhere more urgently demanded than in the complex and important business of public service. Faced by growing demand on the one hand and limited funds on the other, the administrators of this business are caught on the horns of a dilemma from which the only escape is constant improvement. The situation is most pressing perhaps in the primary field of public service, namely water supply. It is this theme to which the present issue of *Engineering News-Record* is devoted.

Domestic and industrial needs for water have rebounded from their lowered depression levels and are once again advancing at a rate that promises to outstrip anticipations. In many cities consumption is at a new high and further increase impends. Quite naturally, therefore, water engineers and officials the country over are studying the problem of how to deal with the increased load and how to improve waterworks performance. Of the 9000 water plants now serving urban population centers, many have reason to be concerned about their ability to give efficient service at low cost.

The answer to the question lies, of course, in improvement—of methods of operation, maintenance and management—to make the system more efficient. In the last analysis this means that new facilities must be constructed, but often such new capital investment can be postponed for many years by taking advantage of means to make the existing plant more efficient.

Elimination of weaknesses in the system is the first essential. Even minor items may be important in the aggregate. Waste and leakage, for example, are responsible for a large total of loss; leakage surveys and campaigns of waste reduction therefore are profitable. For like reasons, water-main cleaning may make it possible to defer costly extensions by increasing the carrying capacity of the distribution system. Changes in the network of mains, and especially the addition of proper valve controls, will often succeed in correcting serious pressure deficiencies and also can reduce the damage that results from breaks. Pumping equipment may be rehabilitated to attain greater efficiency at small cost.

But good service today also must have regard for higher quality of water. To enable this to be attained, auxiliary treatment processes and equipment are available. The continuing technical advance of recent years makes it possible to produce good water at low cost under almost any conditions met in practice. Even the control of tastes and odors, reduction of excessive hardness and removal of objectionable iron and manganese offer no great difficulties in the present-day state of the art. Well-studied improvement to realize these possibilities of quality betterment is worthy of the water engineer's careful attention.

Finally, better organization and management offers large possibilities in raising efficiency and economy of water service. The waterworks is a community's most important utility; poor organization is harmful to both service and revenue. Vigilant administration therefore will concern itself with making the management system efficient, the financial policies sound, the accounting, billing and collection procedures thoroughly businesslike, and the utility's public relations constructive.

A number of specific examples that point the way to water system improvement, through better operating technique, or more thorough maintenance, or efficient management method, are brought together in the present issue. The articles have been written by authorities in their respective fields. *Engineering News-Record* is gratified at being able to offer them to the water fraternity as a contribution to public service.

Dispute Over Control

DIFFERENCE of opinion in Congress over whether the President shall receive another WPA blank check presents two main issues. One, raised by the Administration group, is the charge that when Congress proposes to earmark part of the money for specific uses it diminishes the money available for work relief. The other issue, somewhat related, is that the President, if he is given complete control over the money, will be able to help a greater number of unemployed than would be helped under the method of Congress. To avoid false conclusions on these issues it is important to remember the facts.

First, as to diverting money from direct WPA use: The President has made many diversions from the earlier WPA allocations of funds; he has allocated money to a widely varied list of different uses quite outside the WPA or the relief roll. If therefore Congress proposes to make similar diversions from the present appropriation it will be doing nothing beyond what the President has done and what he may be expected to do with the present appropriation.

Second, the charge that earmarking part of the fund for use in flood control or road construction will put fewer men to work than would find employment under Mr. Hopkins' management is equally unsupported. Efficiently used for public improvement purposes the fund will employ as many people and disburse as large a wage payment in the one case as in the other. In fact Congressional earmarking is likely to produce employment more effectively, since part of the money will pass through the general fabric of industry and will therefore have a wider influence than WPA money.

Thus, the real controversy is not over the question of bringing relief to a larger or a smaller number of unemployed workers, but is solely over the question of who shall dictate the method of expenditure. And on this issue one can hardly fail to side with Congress, the people's appointed representative in deciding on the expenditure of public funds.

CURRENT NEWS

Black-Connery Labor Bill

Bill takes jurisdiction over a broad spread of industries in which wages and hours may be controlled

The Black-Connery bill, to be cited as the Fair Labor Standards Act of 1937, which was introduced in Congress last week with administration support, would forbid the shipment in interstate commerce of goods produced under substandard labor conditions. It sets up a labor standards board which would have the duty of determining standards of minimum wages and maximum hours in any industry which comes under the terms of the act and would also be charged with the enforcement of the act.

In its determination of standards, the board is to be guided by a basic wage and hour schedule set up in the act. This schedule has been left blank in the bill as it now stands, but it is generally expected that it will set a minimum standard of a 40 cents per hour wage for a 40-hour work week. Standards are, however, not to be uniform but may vary with industry, locality, size of industry, or population density. In determining the standards for any given classification, the board is to consider cost of living, prevailing wages in the locality, existing union agreements, and the practices of the higher paying concerns in the industry.

The employment of child labor is also included in the definition of substandard labor conditions. Under the terms of the act child labor would constitute employment of any person under 16 years of age or the employment of any person between 16 and 18 in an industry declared by the Children's Bureau of the Department of Labor to be particularly hazardous or unhealthful.

Substandard labor conditions would also include the practice of spying on employees to determine their union affiliations or political or economic ideas and the employment of strike breakers in industrial disputes. Strike breakers are defined in the act as persons temporarily employed during a strike or employed at a wage greater than that paid to the striking workmen for the same work.

In addition to forbidding the interstate transport of unfair goods, the bill would forbid the transportation into any state of goods produced under labor conditions lower than those legal under the laws of that state.

Notable is the wide jurisdiction over industry assumed in the act. Not only is the interstate transport of goods produced under substandard conditions made illegal, but is is also made a punishable offense to employ substandard conditions on goods of which any substantial portion is intended for interstate sale. The act specifically states that a substantial portion need not be a large one. Moreover, the act makes illegal the production under substandard conditions of goods produced and sold entirely within a state, if substandard conditions in the production of such goods would subject interstate goods to unfair competition.

Powers of the board

The Labor Standards Board is given authority to issue orders establishing standards for any classification of industry which it may set up. These orders are to be issued only after a hearing, and the Board has the power to subpoena persons or records in the course of such hearings. The Board may enforce its orders through the courts. Moreover, any employee who has been found by the Board to have been employed at substandard wages or at too long a work week is entitled to enter a civil action to obtain the difference between his wages and standard wages and to obtain overtime pay for the time he has worked beyond the standard work week.

Any person may appeal to the Federal district court against an order of the board, but in such actions the findings of the board as to fact are to be final, and the court may pass only upon questions of law. In addition, any person who fails to present evidence before the board at hearings, is automatically debarred from presenting evidence before a court reviewing the actions of the board.

Reclamation Projects

The major reclamation projects for which appropriations were approved by the House of Representatives when it passed the Department of the Interior appropriations bill May 20 were as follows:

Construction appropriations from the Reclamation Fund were divided among the following:

Arizona, Salt River	$500,000
Colorado, Pine River	500,000
Idaho, Boise-Payette	1,000,000
Montana, Sun River	300,000
New Mexico, Carlsbad	200,000
Oregon, Owyhee	500,000
Utah, Ogden River	250,000
Provo River	750,000
Washington, Yakima-Roza	1,500,000
Wyoming, Casper-Alcova	650,000
Riverton	200,000
Shoshone-Heart Mountain	700,000
TOTAL CONSTRUCTION	$8,250,000

An additional $1,166,600 for operation and maintenance brought the total appropriation from the Reclamation fund to $9,416,600. Appropriations from the general treasury were made for the following projects:

Boulder Dam Canyon Project	$2,550,000
All-American Canal	1,500,000
Central Valley Project	12,500,000
Grand Coulee Project	13,000,000
TOTAL	$38,981,600

Appropriations for Indian reservation irrigation totalled $3,462,000, of which $2,088,000 was for construction.

Traffic Safety Discussed

Traffic engineers question value of grade separation and approve divided lane highways

Traffic segregation, modernized railroad grade crossing protection, and better organization for safety in metropolitan areas were discussed at the Chicago Midwest meeting May 13 of the Institute of Traffic Engineers.

E. J. McIlraith, staff engineer, Chicago Surface Lines, developed a traffic segregation idea wherein 66-ft. streets paralleling main arteries would be turned into one-way streets with coordinated control whereby through traffic would proceed at stated speeds. He held that this would greatly relieve the principal streets of confusion and interference and would be vastly superior to creating additional wide streets jointly used by all classes of traffic. It involves no added expense for property condemnation.

The grade crossing problem cannot be solved by a separation program since more crossings are being made than separated and the cost will run to as much as the present cost of the railroads. Compared with the total traffic toll, grade-crossing accidents are relatively minor. Yet, said George W. Barton, traffic engineer of the Chicago Motor Club, engineering methods can save 700 to 1000 lives a year. Some of the points made are as follows: The crossing problem is increasing, since rail traffic and speed are on the increase. The nature of crossing accidents indicates that the fewest number and smallest percentage of accidents per crossing occur where gates are installed. Most occur at unprotected crossings, although the highest percentage occurs at crossings with visible signals and with watchmen. Illumination of crossings would eliminate many of the accidents caused by motorists running into the side of trains, since 75 per cent of them occur at night. Unreasonable traffic control due to outmoded signs and signals at crossings have led the motorist to ignore them. Reasonable operation is being provided in a few places, with gates lowered early for a fast train and much later for a slow train. Niles Center, a Chicago suburb, and Palo Alto, Calif. have such installations.

Suggestions were made that crossings be equipped with timed control and that the wigwag or flashing light be replaced by an actual barrier carrying adequate flashing warning lights and floodlights to illuminate the gate. Costs of adequate protection were estimated at $4,000 to $15,000 per crossing.

W. H. Klapproth, district traffic engineer, Illinois Division of Highways, pointed out the complications in enforcing safety measures arising in the 87 suburban communities clustered about Chicago. He outlined the essential features of an inter-community safety organization to analyze the quantity and quality of traffic enforcement and to encourage selective enforcement program.

FORT PECK'S SAFETY VALVE

COMPLETION of the 2-mile spillway — the safety valve for a 19,500,000-acre-ft. reservoir — will be a major construction operation this season at Fort Peck Dam. This photo is taken from the lower end of the mile-long lined section, looking toward the inlet control gates, the piers for which can be seen in the background. Slots are cut in the shale of the sloping sides of the cut as keyways for the wall concrete, and the shale is covered with cement mortar to check disintegration pending placement of concrete. Excavation of the shale cover, left as a protection when the general cut was made, remains to be done on the far side.

Contractor Found Liable For Workman's Death

Paul Bacco, Stamford, Conn., road building contractor, has been found criminally liable for the death by electrocution on a construction job May 1 of Cesidio De Benedictis. Bacco was responsible for failure to turn off a switch controlling electric power lines adjacent to the operation of a steam shovel on the Rocky Craig road job, it was found.

At the time of the accident workmen were pouring concrete into a bridge structure which was being rushed for completion within the hours of daylight. The concrete mixer was under the direction of Bacco. A steam shovel nearby worked in unison. Two power lines, one of 3400 volts, ran 25 feet above the bridge. In order to pour the concrete the boom of the shovel carrying the bucket had to be raised above these wires.

It was well known to Bacco that the switch nearby could be used to shut off the current and had on other occasions been used as a safety measure with the standing permission of the power company. The finding reads further as follows:

"With the knowledge that Bacco had, it would have been a simple matter for him to have notified the power company and shut off the power during the day that this concrete was to be poured. Instead of this Bacco pursued the course of notifying the laborers who were handling the scoop to be more careful, that if the boom or cable suspended therefrom came in contact with these wires injury might result, and they were accordingly warned.

"These men were very busy endeavoring to get the job done as demanded, and could not be expected to realize the danger they were in, with the result that at one time during the operation the cable of the steam shovel was moved in operation thereof within 18 in. of this high tension wire. De Benedictis, in carrying out his part of the job, pushed the scoop containing the concrete to an advantageous position by hand, with the result that the cable came in contact with the wire, and caused De Benedictis to be electrocuted.

Senate Approves Investigation Of Propaganda on Power

A resolution appropriating $150,000 for a Federal Trade Commission investigation into the efforts of privately owned utilities to influence public opinion upon the subject of municipal ownership of utilities was passed by the Senate May 17 without a record vote; the resolution was introduced by Senator Norris of Nebraska. Amendments, introduced by Senator King of Utah, were added extending the scope of the inquiry to include efforts of governmental and other agencies to influence public opinion in favor of public ownership, the amounts of grants and loans made by the federal government for such purposes, and the decrease in tax receipts resulting from the construction of municipal and other publicly owned power facilities.

These amendments were accepted by Senator Norris, who then added to the list of subjects for study an inquiry into rate reductions attributable to the increase in public power.

New Drought Feared In Dust Bowl

Rainfalls far below normal in Great Plains states create conditions as bad as last year

During the debate in the House of Representatives on the relief bill, Representative Case of South Dakota stated that rainfall deficiencies in the Great Plains area during the first part of 1937 indicate the possibility of another serious drought. Figures presented by Mr. Case were:

In north central Texas, rainfall for the year to May 21 was only 22 per cent of normal. For the same period, the proportion of normal in western Oklahoma was 30 per cent; in central Kansas 39 per cent; in western Kansas 20 per cent; in western South Dakota 42 per cent. In the eastern part of South Dakota rainfall was normal until May 1, but only 5 per cent of normal during the next three weeks.

Secretary of Agriculture Wallace, has announced that a co-ordinating committee has been appointed under the leadership of M. L. Wilson, assistant secretary, to deal with the drought menace in the dust bowl states. The announcement followed the report of the Weather Bureau that high winds and unrelieved heat had accentuated conditions which already had been declared as "bad as those of 1936." The Bureau's report said that the drought is serious in the western third of the Dakotas and Nebraska, much of eastern Montana, the eastern third of Wyoming, parts of eastern Colorado, and on into western Kansas. There has been a shortage of water on these sections for five months.

J. B. Kincer, chief of the Weather Bureau's climate and crop weather work, said: "Conditions in that area are just the reverse of those of a year ago. During May 1936 adequate rains fell in the dust bowl. During the last month little or no rainfall has occured and there is no reserve moisture in the soil."

At a press conference Secretary Wallace declared that a co-ordinating program is being drafted by the Department, and that the Resettlement Administration has loaned $8,000,000 to 18,200 dust bowl farmers, made grants of $1,815,194, and spent $905,888 in buying 284,784 acres of the poorest land in the dust bowl area.

New Welding Society Manager

Warner S. Hays has been appointed managing director of the American Welding Society. Mr. Hays is a graduate of Yale Sheffield Scientific School in electrical engineering. He worked for several years in the testing and engineering department of the General Electric Company and has been purchasing agent and district general manager of the Interurban & Traction Lines of Rockford, Ill., and later of the Light, Power & Traction Lines of DeKalb and Sycamore, Ill.

He served as circulation field manager of the McGraw Publishing Company in New York until the war, during which he served as an officer in the construction division of the Army. Since the war, Mr. Hays has maintained his own consulting engineering and association executive office in Philadelphia.

Mine Tailings Slide Destroying Town

Gold mine tailings piled above Mexican town slide after heavy rain killing seventy

Three days of rain loosening the stored tailings from the Dos Estrellas gold mine brought 14,000,000 tons of semi-liquid mud pouring down upon the town of Tlalpujahua in the state of Michoacan, Mexico, on the morning of May 27. Seventy bodies have been recovered from the ruins of the town, in which 300 houses were destroyed.

The Dos Estrellas Mining Co., which is controlled by French capital, estimates the damage at several million pesos and states that it will be impossible to resume work for some weeks.

Although the disaster was referred to in the newspapers as a "dam collapse," what occurred was more in the nature of a landslide. Since 1889 the Dos Estrellas mine has disposed of tailings by terracing them on the steep slopes of the narrow valley above the town. Small dikes of the dried material are thrown up by the peon workers to retain successive poundings of tailings from the mill. In this way waste material could be stored conveniently, although in time the terraces build up to great heights and because of the steep slope menace the valley below.

In previous years, when rains have followed terracing to a considerable height, there have been repeated slips of this material.

In the present case, three days of heavy rains saturated the successive dikes, and the surcharge behind them caused a repetition of the slides that have occurred before. Instability of the fill had been noted the day preceding the disaster, and inhabitants of the town had been warned to evacuate. This accounts for the comparatively small loss of life.

Eric J. Baker Photo

SIMPLIFIED ROOF FRAMING ADMITS MORE LIGHT

BY USING welded frames to support the roof monitors, instead of the more conventional trusses, the designers of the new General Motors assembly plant at Linden, N. J., Albert Kahn, Inc., have provided the workers with a maximum of daylight. Such framing is used in 15 of the 18 bays, the center and outside bays being spanned by trusses to provide lateral rigidity.

The huge plant, one of the largest automobile factories in the country, is 1080 ft. long and 680 ft. wide. It was opened with ceremonies on May 27, after the contractor, the J. A. Utley Co., had built it in the fast time of 5 months. Construction supervision for the General Motors Corp., was handled by W. S. Roberts who has served in a similar capacity on new General Motors plants at Los Angeles, Atlanta, Baltimore, Buffalo, and Sao Paulo, Brazil.

Baton Rouge Bridge Cost To Be Eight Million

Low bids received by the Louisiana highway commission May 26 for superstructure and foundations of the main span and approaches of a combination railway and highway traffic bridge across the Mississippi River at Baton Rouge totalled $8,361,000. The estimated overall cost of the structure was $7,000,000, of which $5,000,000 was to be provided from state bond sales and $1,500,000 from the U. S. Bureau of Public Roads.

Low bidder for the substructure on the main river bridge was the Kansas City Bridge Co. of Kansas City, Mo. with a bid of $2,421,980. Siems-Helmers, Inc., of St. Paul, Minn., were second with a bid of $2,173,575.

For the superstructure, the Bethlehem Steel Co. of Bethlehem, Pa., made the low bid of $3,708,000, with the American Bridge Co. of Pittsburgh, Pa., bidding second at $3,866,000.

Uvalde Construction Co. of Dallas, Texas, bid $598,000 for the substructure of the approaches, and Robinson & Young of Baton Rouge, La., were second with a bid of $633,000. Low bid for the superstructure of the approaches was $1,635,000, offered by the Steel Construction Company of Birmingham, Ala. The Virginia Bridge Co. of Roanoke, Va., was second with a bid of $1,639,000.

The bridge, which is to be toll-free to highway vehicle traffic, will have an overall length of 12,000 ft., of which 3,326 ft. will be over the river. The main span will be a cantilever with a vertical clearance of 65 ft. above high water and a maximum horizontal clearance of 848 ft.

The structure will carry one railroad track and two 20-ft. highways.

Foundations, which will be concrete piers, extend to depth of 180 ft. Construction of the entire bridge will involve placing of 93,000 cu.yd. of concrete, driving of 180,000 lin.ft. of precast piling, and erection of 37,000 tons of steel.

Harrington and Cortelyou of Kansas City are consulting engineers.

Court Dismisses Arizona Suit For Control of Bartlett

A federal court has dismissed a suit entered by the state of Arizona seeking to place the construction of the $4,000,000 Bartlett dam under the jurisdiction of the state engineer and to force its builders, the U. S. Government and the Salt River Valley Water Users Association, to obtain a state permit.

The suit sought an injunction against erection of the dam under the terms of a state law which requires that dams more than 15 ft. high and impounding more than 10 acre-ft. of water be built under the direction of the state engineer.

Bar on Tax Diversion Held Illegal

The Massachusetts Supreme Judicial Court has given the Legislature a ruling against a proposed amendment to the state constitution under which the revenue from gasoline used by motor vehicles would be delegated exclusively to highway purposes. The Court held that the power of the state to disburse funds is in the hands of the Legislature and cannot be altered by constitutional amendment.

Twenty-five Million Bid For Queens Tunnel

Low bid received by the New York City Tunnel Authority for construction of tubes and ventilation shafts for the $58,000,000 Queens Midtown Tunnel under the East River connecting Queens and Manhattan, New York City, was that of the Walsh Construction Co. of Davenport, Iowa for $24,764,000. Mason & Hanger of New York City were second with a bid of $27,788,000.

The work to be performed under this contract, largest yet to be awarded in connection with the tunnel, includes the construction of two tubes under the East River, lined with cast iron forms and driven by the shield method under compressed air. Also included is placing of permanent and temporary clay blankets over the river bed in the East River, removal of the temporary blanket, and completion of ventilation shafts.

Unions Protest Discharge Of State Highway Men

The Olympia Trades Council, of Olympia, Washington, has protested to the Washington state highway director over the laying off of five state highway department employees, allegedly for union organization activity. The men were members of the Association of Highway Engineers, an A.F. of L. union. One of the men, Richard Linton, is president of the association.

The Trades Council, in a resolution, proposed to "take such action as may be necessary to effect reinstatement of these members to their former status."

The highway department answered that the layoffs in question were "just a normal reduction of personnel."

Company Plans Compromise With Irrigation District

Proposing that the entire $2,760,000 PWA electrification loan and grant to the Imperial Irrigation District be spent for the construction of hydro-electric plants 2, 3, 4 and 5 on the All-American Canal, the Nevada-California Electric Corp. has submitted to the district directors a plan for cooperative settlement of a power controversy involving duplication of the private company's service and facilities by the district. The corporation asserts that revenues from such development will repay the entire cost of the canal in 40 years.

Terms of the proposal include: (1) construction of 33,760 kw. of generating capacity on the All-American Canal by the district; (2) district to reserve energy required for desilting, pumping and drainage, and corporation to deliver this energy at a reasonable transportation charge; (3) corporation to purchase all energy capable of being distributed to its present and future customers in Imperial and Coachella valleys and in Mexico for 40 years at a rate of 5 mills per kw.-hr. and any additional energy produced by district at 1.5 mills per kw.-hr. (4) corporation to purchase district's present distribution facilities and Brawley diesel plant; (5) corporation to expend $700,000 in twelve months for further rural electrification.

Estimates by the corporation based on Reclamation Bureau water flow plans, indicate a net return to the district over a 40-year period of $27,793,100 which would be applied against the $26,710,000 estimated cost of the canal. Under the terms of the agreement the district would be empowered to take over the transmission and distribution facilities of the company at a fair value any time that the company defaulted on its obligations.

Present plans of the district call for construction of only two plants aggregating 9,250 kw. on the canal with 70 per cent of the PWA loan and grant to be spent for distribution and standby facilities. In addition the district has a $700,000 allotment from REA for rural electrification.

The power utility asks that its proposal be brought before the voters of the district before the directors irrevocably commit the district to the existing plan. At present the company has 58 per cent of the domestic customers and 48 per cent of the large commercial customers in the valley signed up on long term contracts.

Mathieu Photo

NEWARK TERMINAL

THE SECOND stage of terminal development in Newark, N. J. is nearing completion. At the right are the platform and tracks of the Pennsylvania main line and the station, which is at street level. At the left are the tracks and platform for the new station of the Hudson and Manhattan Railway (the Hudson tubes) which will replace the old Park Place tube station in Newark. Below street level is the new terminal of the Newark Rapid Transit Lines.

Properties of Malodorant Gas Recommended by Commission

The Gas Utilities Division of the Texas Railroad Commission has issued a report, based on findings of the U. S. Bureau of Mines, on the best means of carrying out the provisions of a law passed at the last session of the Texas Legislature requiring that a malodorant substance be placed in all gas used in the state, in order to give warning of leaks. Passage of the Texas law followed the disaster at New London.

The Gas Utilities Division has decided that the odorant to be used in the gas should be of sufficient strength to be apparent to a person coming into a room where the gas is present in proportions of one part of gas to 99 parts of air. Tests indicate that it is more desirable to have an unpleasant than a pleasant odor. Malodorants based on one of the sulphur elements have been found more effective than a smell of bananas or bitter almonds.

The commission lists the following requirements for an effective odorant: It must be harmless. It must be of sufficient strength to show the presence of a very small quantity of gas. It must be noncorrosive to steel, iron, brass, bronze or leather. It must be insoluble in water. It must stay in solution in the gas. The products of combustion of the odorant must be harmless.

It was also found that it would be desirable if the odorant used were slightly irritating to the eyes or nose of a normal person within the period of ten seconds after coming from fresh air.

Washington Highlights

By Paul Wooton

Final preparation of a flood control bill to authorize projects needed to supplement those contained in the Omnibus Flood Control Act of 1936 will start June 7 when the House flood control committee will begin public hearings. The first witness is expected to be Major General Edward M. Markham, Chief of Engineers, who will be followed by division and district engineers and by representatives of localities affected by the 1937 floods.

President Roosevelt on May 25 approved a bill amending the Flood Control Act of 1936 by permitting the construction of reservoirs in any part of the Connecticut River Valley. As the bill was originally worded, such construction was limited to the States of Vermont and New Hampshire. The effect of the amendment is to give the Chief of Engineers greater flexibility in selecting reservoir sites for flood control on the Connecticut River.

The Senate, in approving the Department of Agriculture appropriation bill, increased the total allowance for the Weather Bureau from the $4,158,000 which was provided in the House Bill to $4,800,000. Of the increase, $594,000 was for additional forecasting facilities necessary to promote safety in aviation, and $24,000 was for flood warning service in the Pittsburgh region. Another amendment by the Senate appropriated $1,360,000 for the construction of a laboratory for testing and research work of the federal department of public roads.

With an attendance of approximately 200, the 35th annual May meeting of the American Road Builders Association was held in Washington May 26-28. A large part of the program was devoted to meetings at which the year's work of the various committees was reported and planned. In addition, the session was addressed by Thomas H. MacDonald, chief of the Bureau of Public Roads, L. E. Boykin, chief of the Bureau's Division of Laws and Contracts, R. Gordon Waggonet, Director of the Bureau of Unemployment Compensation, Social Security Board, Benedict Wolf, secretary of the National Labor Relations Board, and Willard T. Chevalier, president of the Association.

Appropriations for non-military expenditures of the War Department are being handled by the House of Representatives in a separate bill. This is the first time they have not been a part of the bill which also carried the appropriations for military purposes. An effort will be made in the Senate Appropriations Committee to combine the two measures in one bill. It would be difficult for the President to veto a bill providing the money for the entire military establishment. If the non-military bill were to go to the President as a separate measure with flood control appropriations greatly in excess of the amount recommended by the Bureau of the Budget, it would be easy for the President to veto the bill on that ground. The non-military appropriation bill probably will be reported to the House early in June. The military section of the bill is already in the hands of the Senate Committee, but it will be held in that committee until the non-military bill is received.

Brief News

PIEDMONT DAM, fifth of the 14 dams in the $43,000,000 Muskingum flood control and conservation project, has been completed. Other dams which have been completed are Mohicanville, Charles Mill, Senecaville, and Tappan. The Piedmont Dam cost $1,234,000.

REMOVAL of the New York Central tracks from the Terrace and Church St. in Buffalo, N. Y. will be ordered after a review of the facts gained from a number of hearings, it has been indicated by John O'Connor, chief grade separation engineer of the New York State Public Service Commission. The city of Buffalo has been making efforts for many years to bring about this grade separation.

THE LAST SECTION of the new Marine Parkway Bridge at New York City, crossing Jamaica Inlet and connecting the boroughs of Brooklyn and Queens, was floated into position May 24. The bridge, slightly more than 4,000 ft. long and containing a central 500-ft. span which will be the longest highway lift span in the world, is scheduled to open July 3, 12 months after it was started.

THE CALOOSAHATCHEE RIVER — Lake Okeechobee drainage project in Florida will be modified, according to recommendations of the Board of Engineers for Rivers and Harbors, to provide for a lock in the St. Lucie Canal with a usable width of 50 ft., and a usable length of 250 ft., and a depth of not less than 8 ft. over the sills and for a new weir structure, at an estimated cost of $806,000. The recommendation is contingent on provision by local interests of all land necessary for the execution of the work.

New York City Housing Project To Be Leased to City

The $4,219,000 Harlem River Houses, PWA housing project in New York City, will be leased to the New York City Housing Authority under an experimental one-year lease which is designed to test the feasibility of operation of PWA's slum clearance and low rent housing projects by municipal housing authorities, the Public Works Administration announced recently. Copies of the lease have been forwarded to the housing authority and final action awaits a formal resolution by the authority approving the lease.

Under the terms of the lease, the authority will take over the project and pay the federal government the sum of $69,000 rent for one year. Payment of this sum is divided into monthly installments starting with $1,000 and working up to a maximum monthly payment of $8,000. This is the first such arrangement undertaken by the PWA.

The Authority agrees to rent the dwellings of the project to tenants in accordance with a fixed rent schedule set forth in the lease and agrees to restrict tenancy to those families qualified under the law.

Rents specified by the lease average $4.73 per week for a two-room apartment; $5.20 for a three-room unit; $6 for four rooms; and $6.70 for five.

Acme photos

DIVIDED ROADWAY EXPERIMENTS

A VARIETY of designs are being installed in the center strip of an experimental highway in California in an effort to keep motorists off.

Black and white arrows raised about ⅜ in. from the pavement have been placed in the 6-ft. center section of the four-lane highway between Los Angeles and Pomona. The raised construction serves to make the arrows visible in headlight beams and provides a series of slight bumps like that of a flat tire.

Other designs with the same purpose may be seen in the background. The nearest is a series of rough black top sections about 5 ft. long and 5 ft. apart, and beyond that is a railroad tie effect of narrow rough sections.

Rolled Fill Bids Received For Sardis Dam

The Hooper Construction Co. of Bunnell, Fla., submitted the lowest bid of five for $670,655 covering construction of 1,982,000 cu.yd. of rolled fill, 2,720,000 yd. excavation, and installation of a pipe toe drain system for Sardis Dam when bids were opened by the U. S. Engineers May 25. The low bid was less than the estimate of $768,604.

The main portion of the $14,000,000 Sardis Dam will consist of a hydraulic earth fill. Bids on this work were rejected some time ago (*ENR*, April 22, 1937, p. 605) when the bids exceeded the estimate, and it was announced that the army would build this portion of the dam by force account. The rolled fill covered in the present contract will top the hydraulic fill section.

Sardis Dam will be built on the Little Tallahassee River near the town of Sardis, as the first of four reservoir projects planned for flood control in the Yazoo valley. The main embankment will be 96 ft. high and 8,700 ft. long, flanked by earth dikes totaling 4,300 ft. in length.

City Offers to Compromise Water Plant Valuation

The City Council of Newport, R. I. has voted to offer the Newport Water Corporation $2,250,000 for its property, in an effort to settle long-drawn-out litigation in the courts as to the value of the property.

It is understood, according to the Council committee, that the company would be willing to settle for $2,400,000, while the city engineer has valued the property at $1,750,000 plus $200,000 for intangibles. The city officials offer the present compromise in the belief that protracted litigation, even with a favorable settlement, might bring the final cost to $2,225,000.

Hearings have been in progress for some weeks before three commissioners appointed by the courts.

Big Mississippi Road Program Progresses Rapidly

It will be possible to effect complete relocation, grading and drainage of all the 2,700 miles of the priority system of Mississippi's highways with the proceeds of the state's $42,500,000 road bond issue plus federal contributions, Governor White announced May 26. It will be necessary, however, to issue an additional $6,000,000 in bonds to match $4,500,000 in federal money in order to complete the paving, he said. The state legislature will be asked to authorize issuing the necessary bonds when it meets in January 1938.

With the approval of bids opened by the Mississippi highway commission on May 25, a total of $28,500,000 in construction projects will have been contracted for. An additional $4,000,000 has been expended for rights-of-way, maintenance, and engineering and administrative expense, bringing the total to $32,500,000. About three-quarters of the work involved in the program has been placed under contract and about two-thirds has been completed. There still remains $10,841,000 of the authorized bond issue to be placed on the market.

Good Water Prospects At Boulder Dam

Approximately 9,500,000 acre-ft. of water will flow into Lake Mead from the Colorado River watershed before the end of July according to estimates based upon eighty separate snow-survey courses, S. O. Harper, acting chief engineer of the Reclamation Bureau has announced. Present information on snow conditions indicate spring flood run-offs from the principal tributaries of the river as follows:

	Acre-ft.
Colorado River at Palisade, Colo.	2,000,000
Gunnison River watershed	1,500,000
Green River (Wyoming)	1,100,000
Green River (Utah tributaries)	1,000,000
White and Yampa rivers	1,400,000
San Juan and Dolores rivers	2,500,000

With a present storage content of 11,000,000 acre-ft., it is expected that Lake Mead will contain 17,000,000 acre-ft. by the end of July after allowance for required downstream irrigation and power requirements. Normal inflow will hold the lake at that level throughout 1937.

Construction Wage Rates Set By New Mexican Commission

In accordance with the terms of an act approved last March the New Mexico State Labor Industrial Commission has established wage rates found to be prevailing for construction labor in the ten districts into which the state is divided by the commission. A rate of 40 cents per hour for unskilled labor and of 55 and 75 cents for truck operators is set as the minimum throughout the state. Wage rates for skilled labor vary, with the trade and with the district, from $1 to $1.50 per hour.

The act, approved last March, provided that advertised specifications for every contract in excess of $2,000, to which the state of New Mexico or any political subdivision thereof is a party, for public buildings, public works or public roads in the state of New Mexico, must contain a provision stating the minimum wage rates to be paid various classes of labor, which are to be based upon the wages determined by the state labor commission to be prevailing in the region in which the work is to be performed. The contracts for such work shall require that the contractor pay at least the prevailing wages.

The law further provided that if any contractor is found to pay less than the established rates his contract may be immediately terminated and completed by another contractor, the guilty contractor to be liable for any excess cost occasioned by such action. The guilty contractor will not be permitted to bid on any state work for a period of three years.

Workmen who received less wages than is required under the act shall be paid the extra amount due them from any funds withheld from the contractor under the terms of the contract. If such funds prove insufficient, the workmen shall have right of action against the contractor for any remaining sums due them.

Nebraska Districts May Buy Power Companies

Three PWA-financed public power districts in Nebraska are reported to be negotiating for the purchase of the systems of four privately-owned utility companies operating in the same area in order to organize a widespread combined system utilizing both hydroelectric and steam generators to serve a large proportion of the state. The success of the negotiations depends upon agreement of the opposing factions as to price, and it is reported that the utility representatives are taking a "reasonable" attitude in this regard.

The public bodies concerned are the Platte Valley, Loup River, and Central Nebraska Public Power and Irrigation Districts; the utilities are the Nebraska Power Company, Iowa-Nebraska Light & Power Company, Western Public Service Company, and Central Power Company. In May, 1936, these companies obtained a temporary injunction against construction of the three projects which was subsequently modified to permit construction of the irrigation features, but forbids interconnection into a unified power distribution system.

SOCIETY CALENDAR

AMERICAN WATER WORKS ASSOCIATION, annual convention, Buffalo, N. Y., June 7-12.

WATER WORKS MANUFACTURERS ASSOCIATION, annual meeting, Buffalo, N. Y., June 8.

ENGINEERING INSTITUTE OF CANADA, semi-centennial celebration, Montreal and Ottawa, Canada, week of June 15.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, annual meeting, Urbana, Ill., June 21-24.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer convention, Milwaukee, Wis., June 21-25.

AMERICAN SOCIETY OF ENGINEERS, annual meeting, Urbana, Ill., June 21-24.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Cambridge, Mass., June 28-July 2.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, New York City, June 28-July 2.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Detroit, Mich., July 21-24.

PENNSYLVANIA SEWAGE WORKS, Annual conference, State College, Pa., June 21-23.

LICENSE EXAMINATIONS

IOWA: Examinations for professional engineers June 8 and 9, and examinations for surveyors June 10 in the Senate Chamber at the State House, Des Moines, Iowa.

MICHIGAN: Examinations for architects at the University of Detroit and examinations for engineers and surveyors at the University of Detroit, the Michigan State College, the Michigan College of Mines, and at Ironwood, June 21-23. Information may be obtained from the Michigan State Board of Examiners, 306 Transportation Building, Detroit.

Alternative Wage and Hour Bill Would Regulate Unions

Federal regulation of labor unions as well as the establishment of minimum wages and hours would be provided for in a bill introduced into the House by Representative Hartley of New Jersey as an alternative to the Black-Connery bill. It is understood that the bill is shortly to be introduced into the Senate by a prominent Republican.

The proposed bill would bar from interstate commerce products produced under substandard labor conditions by requiring each manufacturer to obtain a license from the Federal Trade Commission, the license to be issued only upon agreement to adopt maximum working hours of 8 per day and 40 per week and minimum wages to be determined for the industry by the Federal Trade Commission and to employ no persons under 16 years old. The minimum wages determined by the commission could not be less than $14 per week.

The bill would also prohibit any labor organization from acting as an agency in collective bargaining until it had been issued a license by the Federal Trade Commission. This license would be issued only upon agreement to refrain from enrolling members by threat, intimidation or violence; damaging or destroying property or violating property rights; striking in violation of any agreement previously entered into; and using physical violence or threats or intimidation in connection with any strikes.

Both types of license would be revocable by the commission for violation of the agreement.

Redesign of Housing Project Saves $145,000

The Public Works Administration has accepted the bid of the A. E. Stephens Co. of Springfield, Mass., for construction of the buildings at Schonowee Village, PWA housing project in Schenectady, N. Y. The amount of the bid was $893,620. Acceptance of the Stephens bid marks a saving in the construction cost of the project of $145,380 over the low offer in a previous letting. Bids were taken for the work some time ago, and at that time the lowest bid submitted was $1,039,000. All bids were rejected, and the project was redesigned.

On the present letting, the Stephens Co. submitted the second low bid. The low bid was thrown out, inasmuch as the bidder failed to qualify under PWA regulations.

Schonowee Village includes five apartment buildings, providing homes for 219 families. The revision of the plans for the development permitted increase in the size of the project by a number of units.

Personals

LT. COMMDR. COLLINS L. MACRAE, Corps of Engineers, U. S. Navy, has been ordered detached from duty at the Naval Station, Tutuila, Samoa, and to duty in the 11th Naval District, San Diego, Calif.

LT. COL. DONALD A. DAVIDSON has been assigned to duty as district engineer at Louisville, Ky., upon completion of his present course of study at the Army War College.

COL. C. L. STURDEVANT, U. S. Engineers, who has been on duty in the Philippines, has been ordered to Kansas City, Mo., as assistant to the division engineer.

CALVIN V. DAVIS, chief engineer of the Ambursen Dam Co., New York City, has been appointed principal planning engineer for the Tennessee Valley Authority at Knoxville, Tenn.

W. K. HATT, retiring head of the Engineering Department at Purdue University, has been awarded the honorary degree of Doctor of Laws by his alma mater, the University of New Brunswick.

CHARLES H. PURCELL, California state highway engineer and chief engineer of the San Francisco Bay Bridge, has been awarded the honorary degree of Doctor of Laws by the University of California.

WALTER L. HURD, who has been employed for the past five years by the Schenectady county, New York, highway department, and has also been practicing privately, has entered the employ of the engineering department of the New York Central Railroad.

E. B. DONOHUE, who has been assistant state engineer for the Montana Highway Department, has been appointed coordinating engineer for the recently organized Montana Water Conservation Board. He has been connected with the highway department for seventeen years.

LEE M. BUSH, who recently left his position as city engineer of Oklahoma

City, which he had held for six years, has taken a position with the firm of Black, Sivalls & Bryson, Oil Refinery Equipment Manufacturers, as a construction engineer. He will supervise enlargement of the company's plant in Oklahoma City.

HERBERT K. FAIRBANKS, chief designer for the New England Public Service Co., of Augusta, Maine, has been appointed chief designing engineer for the Ambursen Dam Co., New York, taking over the duties formerly carried by Calvin V. Davis. Before taking his position with the New England Public Service Co., Mr. Fairbanks was designing engineer for the Ambursen Company.

R. L. MCCORMICK, professor of civil engineering at Rose Polytechnic institute is retiring after 45 years of teaching at that institute. Professor McCormick is a graduate of Rose, class of 1891, and received his M.S. and C.E. from the same institution in 1906 and 1907. Immediately after his graduation from College, Professor McCormick became an instructor in civil engineering at Rose, and progressed through several promotions to the position of Professor Structural Engineering, to which he was appointed in 1916; since 1923 he has been Professor of Civil and Architectural Engineering. Since 1903, Professor McCormick has practiced as a consulting civil and mining engineer, making numerous reports and designs, mostly on bridge, highway and sanitary work, for various private companies and municipalities. He was for some years chairman of the Indiana Board of Registration.

Obituary

IRA L. THOMAS, SR., a pioneer railroad builder in the Southwest, died recently in New Orleans. Among other railroad jobs, he had participated in the construction of the I.&B.M., Southern Pacific Lines, and M.K.&C. railways.

GEORGE R. MCDERMOTT, professor of Structural Design at Cornell University, died in Ithaca on May 26 at the age of 76. Professor McDermott was a native of Scotland, and was educated at Glasgow Academy and Technical Institute. Before entering a teaching acreer he had had experience as a naval architect.

ARTHUR L. REEDER, 57, Philadelphia consulting engineer, died May 24 at Gloversville, N. Y. A graduate in electrical engineering of the University of Pennsylvania, class of 1900, Mr. Reeder early became connected with hydraulic work through his position as electrical engineer for the filtration bureau of the city of Philadelphia. After some years in that position he transferred to the Baltimore city water department as principal assistant engineer on the design of a dam and mechanical filter plant. Then followed brief connections with a number of New York City water consultants, the Pennsylvania department of health and the Cleveland division of water. From 1921 to 1924 he made studies for the bureau of water of Reading, Pa., preparing a program for the extension and improvement of that city's water supply. He was connected for a time with the Harrisburg, Pa., firm of Ganett Seelye & Fleming, and the New York firm of H. Burdett Cleveland.

LARGER AWARDS FOR THE WEEK

Residential development, Housing Products, Inc., Rochester, N. Y.	$1,000,000
Aquarium and marine studio, Summer Haven, Fla.	2,000,000
Museum of Modern Art, New York, N. Y.	1,000,000
Building at Municipal University, Omaha, Neb.	651,000
County jail, Buffalo, N. Y.	685,000
Superstructures of Housing Project H-5801, Schenectady, N. Y.	894,000
Buildings and utilities at U. S. Veterans' Hospital, White River Junction, Vt.	547,000
Paving roads, Richland and Lucas Counties, O.	500,000
Highways, South Carolina	612,000
Highways, Texas	1,115,000
Highways, Nebraska	980,000
Highways, New York	715,000
Highways, Mississippi	1,322,000
Highways, Pennsylvania	991,000
Highways, South Dakota	589,000
Dam No. 25, Mississippi River, Cap au Gris, Mo.	3,781,000

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
June, 1937	237.35	114.09	May, 1937	233	94
May, 1937	232.65	111.85	Apr., 1937	161	71
June, 1936	204.60	98.35	May, 1936	149	65
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

CONTRACTS
(Thousands of Dollars)

	Weekly June 1936	Average Prev. 4 Weeks	Week June 3 1937
Fed. Government	$6,008	$2,855	$6,510
State and Municipal	25,351	24,577	17,886
Total public	$32,335	$27,432	$24,396
Total private	13,644	31,321	11,210
Week's total	**$45,979**	**$58,753**	**$35,606**

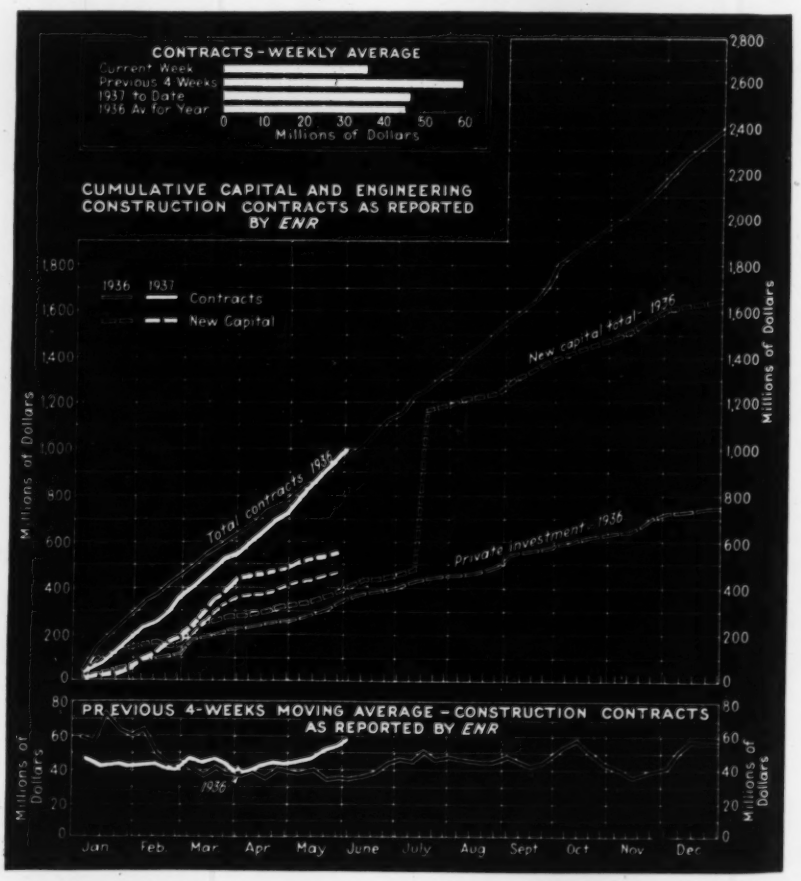
Note: *Engineering News-Record* reports waterworks and earthwork, reclamation or waterways projects of $15,000 and over in size; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000 and over. The figures above represent the volume of contracts and large force account projects throughout the U. S. that are of these minimum sizes or over.

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

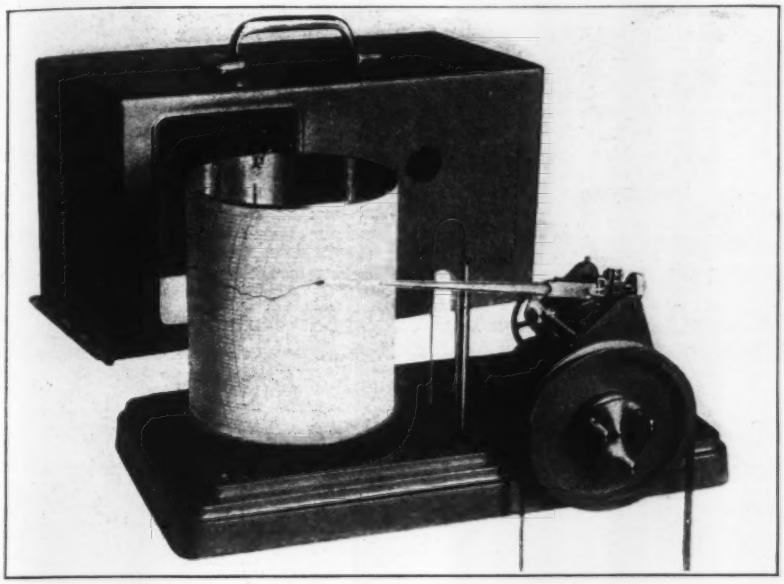
	Week June 3	Cumulative
Private investment	**$25,642**	**$504,499†**
State and municipal bonds	12,192	237,488†
Corporate securities	13,450	267,011
Federal financing	**—8,176**	**70,788†**
PWA non-federal Projects	—8,176	40,856†
R.F.C. Loan	.....	29,932
Total non-federal	**$17,466**	**$575,287**
Federal projects	.....	.....
Total	**$17,466**	**$575,287**
Cumulative to date:		
1936 (23 weeks)		$417,698,000
1937 (23 weeks)		575,287,000

Note: These figures include private bonds and stocks sold for new construction purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self-liquidating" projects, and 25 per cent of WPA construction appropriations.

† Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1937 to Date
1936 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936 1937
Contracts
New Capital
New capital total 1936
Total contracts 1936
Private investment 1936
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Waterworks Equipment and Materials



Water Level Recorder

A new portable water level recorder, Model FW, is manufactured by Julien P. Friez & Sons, Baltimore, Md. In this device a float 6 in. in diameter operates a float wheel by means of a perforated stainless steel tape. The float wheel operates the pen arm through a reducing mechanism and a heart-shaped cam which so guides the pen arm that equal increments of water always move the pen the same chart distance and the lines of the chart are all parallel and equally spaced. This heart shaped cam also causes the pen arm to reverse the direction of movement when it reaches the top or bottom of the chart; thus an unlimited range of measurement is offered in 1 ft. increments by multiple crossings of the 5-in. chart.

The device is furnished in two models, one recording on a chart with straight horizontals and curved verticals and the other using rectangular coordinates.

Time scales are changed by a simple change of clock gears and may be adjusted to provide for one revolution of the recording drum in periods ranging from 6 to 192 hours.

The FW portable recorder, complete with accessories, sell for $70.

Pipe Cutter Improved

The Model A portable unit for cutting and threading pipe and bolts, manufactured by Beaver Pipe Tools, Warren, Ohio, now offers the choice of wheel-and-roller cutoff or automatic-knife cutoff at the same price, enabling the user to select the type of cutoff best adapted to his particular work. The price of either unit is $290.

Walworth Begins Publication Of New House Organ

Walworth Today, a 12 page bi-monthly magazine published by the Walworth Co., 60 East 42d St., New York City, began publication with its May issue.

The new journal features photographs showing new developments in valves, fittings, pipes and tools and practical methods used on various jobs. A lead article, "Creep Testing of Metals," is the first of a series on laboratory technique and its place in industry.

This magazine will be mailed bi-monthly and without charge, on request to the Walworth Company, 60 East 42d Street, New York City.

New Centrifugal Pumps Are Motor-Mounted

A new line of motor-driven centrifugal pumps for capacities from 5 to 1,200 gal. per min. and heads from 10 to 230 ft. has been developed by the DeLaval Steam Turbine Co., Trenton, N. J. The pump is mounted upon the end shell of an electric motor, and the two form a compact self-contained unit with only one shaft and two bearings.

The tunnel casing is of cast iron, and the impeller wearing ring, shaft feed, stuffing box gland, and lantern ring are of bronze. Special materials can be supplied where required.

The pumps are shipped ready for immediate connection to piping and power supply lines and can be installed with the shaft horizontal, vertical or inclined, or the units can be mounted upon a hand truck or suspended from a sling.

Industrial Protective Coatings

The Wailes Dove-Hermiston Corp. announce that they are now producing a completed line of protective coatings for industry. They state that this line presents a compact group of products which is sufficient in variety and color range to take care of most industrial maintenance requirements and at the same time to simplify selection, ordering, and storage.

A new product in the line is the Chromastic aluminum paint; this paint uses a rust inhibiting vehicle identified by its opaque yellow color. Other items are bitumastic black solution and bitumastic super-service black; bitumastic exterior-interior paint, a general all-purpose coating; Florex floor enamel; Bitugloss industrial enamel, for machinery and industrial equipment; Thermastic high-heat aluminum; Chromastic metal primer; and Bitulite mill white.

Quick-Closing Check Valve Eliminates Slam

Positive elimination of slam on pump shutdown is claimed for the new Clearway quick closing check valve developed by the Rensselaer Valve Co., Troy, N. Y.

This valve is so designed that when the water first starts to flow, lifting the valve flap from its seat, the motion of the flap opens a four way valve to a lifting cylinder, operating from the pump pressure, which forces the main valve flap to its full open position, working against a spring. The valve flap is held open against the spring pressure by a latching cam and latch; this latch is held shut by an electric solenoid connected to the pump switch.

If the pump shuts down or the power fails, the solenoid releases the latch and the spring immediately pulls the valve flap shut. This quick action, it is said, gives no opportunity for slam to develop.

The full Clearway straight passage for the flow of water is said to reduce head loss to a minimum even though velocities are high.

Because the check valve flap is held rigidly in the open position while the pump is operating, wear of the entire flap assembly is said to be reduced.

Pipe Laying Equipment Available on Tractor

Caterpillar R6 and R5 tractors have now been made available equipped with Tracklson pipe layers, according to the Caterpillar Tractor Co., Peoria, Ill. The machines lift, lower, carry, and bend pipe and are said to serve as efficient side cranes for other heavy duty lifting service. The entire structure can be removed quickly when the tractor is to be used extensively for other work. The load and boom lines are raised and lowered under power by means of worm-driven winches, insuring greater safety and complete control of the load. The pipe layer is powered from the Caterpillar rear power takeoff through a ball bearing mounted friction clutch.

BUSINESS SIDE OF CONSTRUCTION

May Construction 66 Per Cent Over 1936—Buildings Show Wide Gains

ENGINEERING construction awards for May total $235,012,000, the highest dollar volume of 1937, and the highest for any May since 1930. This a 36 per cent gain over the five-week April and a 66 per cent increase over May, 1936. Private contracts exceed public for the fourth successive month and are 40 per cent above last month, and 230 per cent above last May, while public construction is 31 per cent above last month and 6 per cent above 1936. This is the first month this year in which public awards have gained over 1936. May's total includes private, $125,283,000; and public, $109,729,000, of which $11,421,000 is federal. The April total, $216,955,000, is made up of private, $112,073,000; and public, $104,882,000, including $16,121,000 in federal awards, and the May, 1936 total, $141,257,000, consists of private, $38,037,000; and public, $103,220,000, of which $12,031,000 is federal.

In the classified construction group May weekly averages gained over April in streets and roads, 23 per cent; public buildings, 31 per cent; industrial buildings, 39 per cent; commercial buildings, 52 per cent; bridges, 74 per cent; sewerage, 1 per cent; and unclassified construction, 52 per cent, and lost in waterworks, 24 per cent; and earthwork and drainage, 12 per cent.

May weekly averages increased over May, 1936 in streets and roads, 2 per cent; public buildings, 14 per cent; industrial buildings, 247 per cent; commercial buildings, 237 per cent; sewerage, 29 per cent; earthwork and drainage, 37 per cent; and unclassified construction, 102 per cent, and decreased in bridges, 32 per cent; and waterworks, 43 per cent.

Geographically, the Middle West states reported a 20 per cent loss compared with last month. West of the Mississippi group and the Far West each lost 6 per cent. The Middle Atlantic section recorded the highest gain, 96 per cent. Compared with

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY *ENGINEERING NEWS-RECORD*, IN MAY, 1937

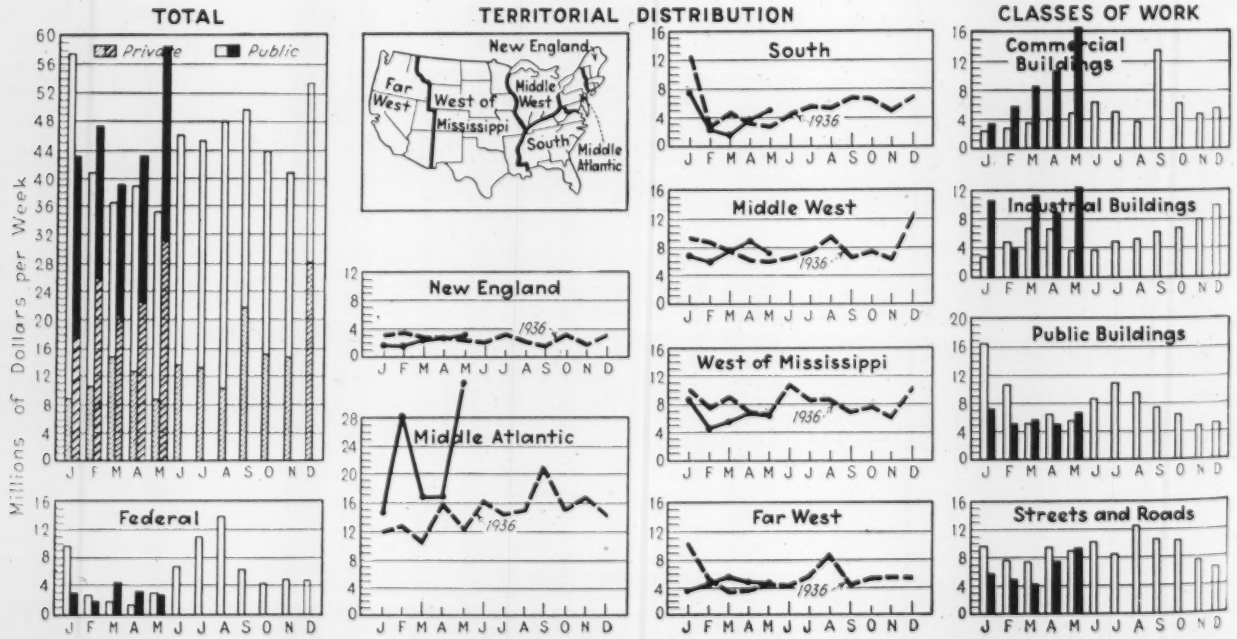
Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States May 1937	United States Five Months 1937	United States Five Months 1936	Canada
Public Works										
Waterworks	457	705	165	413	1,054	1,129	**3,923**	37,700	53,422	151
Sewerage	481	4,800	1,088	1,294	1,160	20	**8,843**	43,795	63,778	135
Bridges	1,166	4,527	857	2,686	1,177	287	**10,700**	44,816	70,923	2,141
Earthwork and waterways	669	1,418	383	410	1,651	1,590	**6,121**	36,948	63,963	498
Streets and roads	1,311	7,660	7,174	8,623	8,743	3,500	**37,011**	134,333	196,622	10,947
Buildings, public	4,040	14,099	1,425	2,795	2,857	1,556	**26,772**	125,854	199,710	650
Unclassified, public	54	11,809	1,003	221	1,640	1,632	**16,359**	53,403	44,988	829
Total public	8,178	45,018	12,095	16,442	18,282	9,714	109,729	476,849	693,406	15,371
Federal government (included in above classifications)	845	2,558	905	1,658	2,357	3,098	11,421	72,281	88,334	.....
Private										
Bridges, private	.....	996	.....	.....	.....	.....	**996**	3,896	3,937	.....
Buildings, industrial	1,355	28,969	6,800	7,210	2,012	3,723	**50,069**	202,157	106,220	2,031
Buildings, commercial	2,890	53,965	650	2,835	1,885	3,330	**65,555**	195,197	76,771	725
Unclassified, private	105	2,056	369	1,772	2,911	1,450	**8,663**	92,930	57,124	80
Total private	4,350	85,986	7,819	11,817	6,808	8,503	125,283	494,180	244,052	2,836
Total Engineering Construction										
May, 1937 (4 weeks)	12,528	131,004	19,914	28,259	25,090	18,217	235,012	.....	.....	18,207
April, 1937 (5 weeks)	12,685	83,686	18,681	44,293	33,447	24,163	216,955	.....	.....	15,341
May, 1936 (4 weeks)	10,652	51,447	11,123	22,881	27,852	17,302	141,257	.....	.....	2,091
Five months, 1937	48,313	453,516	84,959	154,161	132,890	97,190	.....	971,029	.....	52,071
Five months, 1936	66,921	282,974	117,896	168,357	179,252	122,058	.....	.....	937,458	33,358

ENGINEERING CONSTRUCTION REPORTED BY *ENR* WEEKLY AVERAGES

□—1936 ■—1937



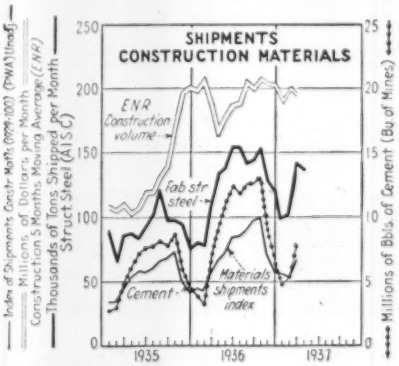
May, 1936, the West of the Mississippi group lost 10 per cent, while all other sections gained, the Middle Atlantic states recording the highest gain, 155 per cent.

New Capital

New capital for construction purposes totals $70,351,000 for May. It includes $40,706,000 in state and municipal bonds, $27,948,000 in corporate security issues, $897,000 in PWA allotments, and $800,000 in Reconstruction Finance Corporation loans to private industry. Private investment capital continues high, constituting 97.6 per cent of the new construction capital in May.

Materials

Steel—The operating rate of the steel companies having 97.7 per cent of the steel capacity of the industry averages 90.8 per cent of capacity for May, compared with 91.0 per cent for April, and 69.1 per cent for May, 1936, according to reports



of the American Iron and Steel Institute. The fall in the operating rate for May is due to strikes in the large independent companies.

Bookings of fabricated structural steel for April total 148,152 tons and shipments total 136,042 tons, as reported by the American Institute of Steel Construction. The first four months of 1937 are 27 per cent above 1936 in bookings and 20 per cent above in shipments. Bookings for the first four months are 65.2 per cent of normal, compared to 51.5 per cent last year. Shipments are 51.4 per cent of normal, compared to 42.7 per cent in 1936 (normal being the annual average, 1928 through 1931).

Lumber—For the first three weeks of May the lumber industry averaged 76 per cent of 1929 production and 76 per cent of 1929 shipments, according to the National Lumber Manufacturers Association. Production gained steadily and the third week of May was the highest reported in 1936 or 1937.

Lumber prices are still unsettled, with decreases reported in Atlanta, Chicago, Detroit, Los Angeles, Cincinnati and St. Louis; and increases in Baltimore, Denver, New Orleans and New York.

Building Permits

Permit values for April, $117,525,776, are 2.9 per cent below the March volume and 40.1 per cent above the April, 1936, total, according to reports to Dun and Bradstreet from 215 cities.

New York City values, $27,110,582, are 24.4 per cent below the March total, but double that of April, 1936. The drop in value of New York's permits from March is responsible for the decline in the total permit values.

Permits for the first third of 1937, $392,922,178, are 46.3 per cent above the corresponding period in 1936. All sections, excepting the South Central states report gains.

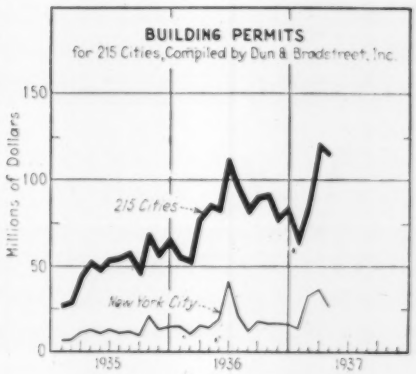
Labor

Private building construction employment during April increased 9.5 per cent over March, and payrolls gained 16.1 per cent, according to reports to the Department of Labor, U. S. Bureau of Labor Statistics, from 9061 contractors employing 106,052 workers. Compared with April, 1936, employment gained 17.1 per cent and payrolls 36.8 per cent. Employees represented by these reports are engaged in erecting, altering, and repairing private buildings and do not include projects financed by Public Works Administration or Reconstruction Finance Corporation funds or regular appropriations of the federal, state and local governments.

The Works Program employed 2,954,000 workers in April, a decrease of 19,000 from March; 2,101,000 of the workers are employed on Works Progress Administration projects. Works Program payrolls amounted to $135,687,000 and over $42,167,000 was spent for construction materials.

Public Works Administration projects employed 189,000 workers, an increase of 15,000 over March. Payrolls exceeded $15,000,000, and material purchased amounted to more than $23,000,000.

The 20-cities wage average compiled monthly by the *Engineering News-Record* is higher for both skilled and common labor. The rise in skilled labor is due to higher rates for bricklayers in Chicago, Cincinnati and New York; for carpenters in Chicago, Cincinnati, Minneapolis and New York; and for structural iron workers in Cincinnati. Common labor



average increase is due to higher rates in Chicago, Cincinnati, Cleveland, Detroit and New York, and is a new all-time high average.

Lorain, Ohio, carpenters and contractors failed to settle a wage dispute, but work on various projects continued under a temporary wage pact. Carpenters demanded $1.15 per hour, an increase of 25c. from their former rate, and refused a compromise offer made by building contractors. The temporary rate is $1.15 per hour in most cases.

Carpenters Council of Essex County, New Jersey, have voted a strike June first, affecting 2,500 carpenters, unless wage and hour demands are met. The Council asks an increase from $1.40 to $1.75 per hour, a seven-hour day, five-day week and that half of carpenters on construction jobs be hired through the Essex County union. Building contractors of Western Essex voted to refuse demands, and threatened legal action to prevent their imposition.

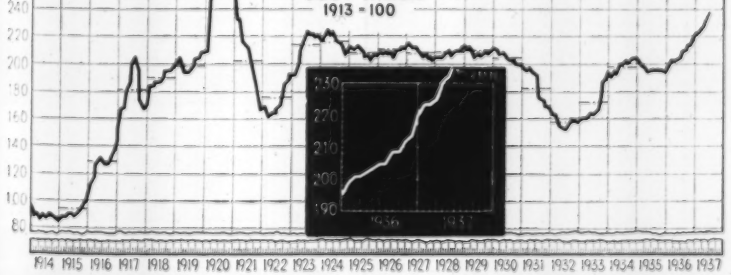
ENR Cost and Volume Index

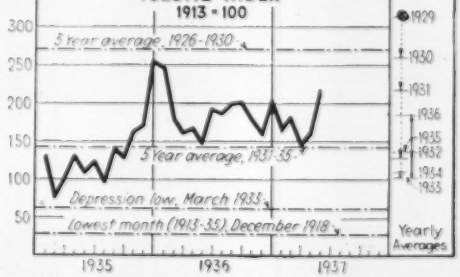
THE *Engineering News-Record* Construction Cost Index rises to 237.35 in June, the highest value since December, 1920. This rise is due to increases in the common labor average rate and lumber price.

The *ENR* Volume Index for May is 213.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
June, 1937	237.35	114.09	May, 1937	213	94
May, 1937	232.65	111.85	Apr., 1937	161	71
June, 1936	204.60	98.35	May, 1936	149	65
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50





CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT — Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL — Per ton, carload lots			CRUSHED STONE — Per ton, carload lots		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Ready Mixed 1:2:4, 50 c.y. or more, delivered
Atlanta	$2.83	$2.58	$2.50	$1.60	$1.60	$1.55	$1.65	$1.75	$1.65	$1.75	$8.90
Baltimore	2.31	2.06	1.86	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.80	1.80	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.25*dl*	2.00*dl*	1.80*dl*	1.20	1.20	.85	1.40	1.40	....	....	7.00
Chicago	2.45	2.20	2.05	1.00	1.00	1.00	1.32	1.32	1.00	1.00	....
Cincinnati	2.53	2.28	2.08	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.45	2.20	....	1.40	1.40	1.30	1.60	1.60	1.75	1.75	7.40*z*
Dallas	2.30	2.05	1.85	1.40	1.40	1.05	1.00	1.05	1.84	1.89	7.00
Denver	3.08	2.85	....	1.20	1.40	.90	....	....	....	....	....
Detroit	2.25	2.00	1.80	1.30	1.30	1.20	1.50	1.60	1.14‡	1.24‡	5.50
Kansas City	2.55	2.30	2.06	1.85	2.30	1.15	1.85	1.80	....	....	7.65
Los Angeles	2.32	2.12	....	1.20	1.20	.90	1.20	1.20	1.05*g*	1.05*g*	6.83
Minneapolis	2.80	....	2.35	1.00*p*	1.00*p*	.25*p*	1.00*p*	1.00*p*	....	....	7.15*t*
Montreal	....	2.07*S*	1.70	.80	.85	1.15	1.20‡	1.30‡	....	....	6.50*t*
New Orleans	2.37	2.12	2.05	1.50	1.50	1.25	....	....	....	....	8.00
New York	2.50‡	2.20‡	....	1.10*tk*	1.10*tk*	.70*tk*	1.65*tk*	1.75*tk*	....	....	7.70
Philadelphia	2.55	2.30	2.10	1.45‡	1.55‡	1.15‡	2.40‡	2.55‡	1.00‡	1.00‡	8.00*D*
Pittsburgh	2.40	2.15	1.95	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.52	2.27	....	1.40‡	1.40‡	1.40‡	.75*p*	.75*p*	.65/.95§	.50/.85§	7.10
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.53
Seattle	2.95	2.70	....	1.33	1.33	1.33	2.25	2.25	....	....	7.50

* 10c allowed for each returnable bag. † Per cu. yd. ‡ Delivered. § F.o.b. Granite City, Ill. *k* Barge lots alongside dock. *p* F.o.b. plant. *t* up to 200 cu. yd. *z* Within 3-mi. from Public Square. *d* 5% discount for cash. *dl* 10% off for cash 10 days. *D* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000 *S* Sales tax included. *g* Crushed granite.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.50	$1.45	Northampton, Pa.	$1.65	$1.60
Crestmore, Calif.	1.72	....	Iola, Kans.	1.70	1.65	North Birmingham, Ala.	1.75	1.70
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	La Salle, Ill.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Hannibal, Mo.	1.70	1.65	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hudson, N. Y.	1.75	1.70	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Independence, Kans.	1.70	1.65	Norfolk, Va.	1.70	1.65	Waco, Tex. (Plus 5c Tax in Texas)	1.75	1.70

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

Uniform carload lot cement price established last March lower peninsular Michigan.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED — Per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE—LOAD BEARING—SCORED — Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK — Per M. in quantity, Common backing	Straight hard	LIME — Per ton, Hydrated finishing	in paper, Common hydrated	carload lot, Pulverized or lump
Atlanta	$63.20	$67.40	$126.30	$126.30	$147.40	$168.40	$12.75	$15.15	$19.50	$14.00	$14.00
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	20.00	14.00	25.00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00§	1.75§	2.25*c*
Boston	86.25*sl*	92.00*sl*	172.50*sl*	195.90*sl*	211.60*sl*	242.00*s*	16.00	19.00	20.00	15.50	3.50*d*
Chicago	66.00	70.40	132.00	174.30	214.40	245.00	10.20	11.20	14.00	12.80	12.00
Cincinnati	56.45	60.40	115.25	138.70	166.50	206.40	17.50	17.50	15.80	12.70	....
Cleveland	49.00	52.00	75.00	117.00	149.00	170.50	16.50	16.50	16.80*k*	14.40*k*	2.65*kp*
Dallas	59.00	62.00	125.00	149.00	155.00	177.00	9.50	24.00	19.00	16.00	.95*z*
Denver	78.50	88.00	141.50	160.65	196.00	225.50	12.00	15.00	30.00*k*	22.00*k*	3.00*k*
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	12.50	13.50	18.00	15.00	16.25
Kansas City	64.50	66.50	81.00*	125.50	159.75	186.25	14.00	24.00	18.90	12.60	10.50
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	12.00	14.00	18.70	....	19.70
Minneapolis	80.35	85.70	146.00	192.85	176.20*n*	245.20*n*	13.10	15.10*x*	21.00	16.00	19.00
Montreal	84.00*s*	96.00*s*	180.00*s*	....	273.00	....	15.50	20.75	23.50	17.00	11.00
New Orleans	72.00	72.00	135.00	162.00	180.00	220.00	14.00	....	18.30	12.60	....
New York	87.00	93.00	139.00*	193.30†	238.80†	295.60†	12.50	....	20.00	15.50	20.00
Philadelphia	85.30	91.00	170.50	204.60	252.00	312.00	15.00	18.00	16.10	10.90	10.40
Pittsburgh	58.40	62.30	116.85	165.00	217.00	250.00	17.50	25.00	17.50	15.00	2.30*p*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	.55‡	.40‡	2.30*p*
San Francisco	84.00	94.50	225.00	....	....	....	15.00	18.00	.55§	.40§	2.05*p*
Seattle	110.00	130.00	210.00	110.00*y*	....	....	20.00*d*	20.00	30.00	20.00	28.60

*6x12x12 in. † F.o.b. Perth Amboy, N. J. ‡ Per sack. § Per bbl., 200 lbs. *p* Per bbl., 180 lbs. *k* LCL. *d* less $1 cash 15 days. *c* Lump. *s* Smooth. *x* Selected common. *l* Carload lots delivered to job. *z* Per sack, 100 lbs. *n* - not load bearing *y* - 8 x 8 x 8 only

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS — Granite per M. lots of 50,000, 4x4x8 in.	Brick per M. 3x4x8½ in., carload lots	Wood per sq. yd., 3½ in. 16-lb. treat	PAVING ASPHALT — Per ton, less than 80 penetration, Tank car	Drums	ASPHALT BINDERS—FLUXES — Per gal., 80-300 penetration, Tank car	Drums	CUTBACK ASPHALT — Per ton, Tank car	Drums	ROAD OILS — Per gal., Tank car	ASPHALT EMULSION — Per gal., Tank car	Drums
Atlanta	$75.00	$35.85	$2.25	$18.20 ²	$23.41 ²	$0.0728 ²	$0.1049 ²	.0768†‡	.1089†‡	$0.0683 ²	$0.0834	$0.0834
Baltimore	130.00	44.00	2.25	17.00	22.00	.075	.10	.09†	.125†	.....	.....	.....
Birmingham	110.00	25.00	....	19.00	24.00	.0878	.1128	.10†	.137†	.....	.06	.....
Boston	75.00	46.00	3.00	17.00	22.00	.07*e*	.095*e*	.09†*e*	.125†*e*	.07*e*	.095*e*	.125*e*
Chicago	140.00	46.00	2.50	18.00	23.00	17.00‡	22.00‡	.07†	.11†	.045	.09	.135
Cincinnati	112.00	37.50	....	13.47	17.47	.12	.....	17.00	.....	.051	.078	.....
Cleveland	100.00‡	37.50	3.00	18.00	21.75	.081	.099	.091†	.061†	.06	.09	.099
Dallas	.....	32.50	....	19.00	22.75	.075	.105	20.00	28.00	.055	.085	.135
Detroit	.....	35.00	....	16.72*k*	21.97*k*	.....	.....	15.60	20.60	.0535	.1125	.1525
Kansas City	.....	44.00	....	18.50	23.50	.077	.1075	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	....	10.00	15.16	11.00‡	15.16‡	11.00	.....	.042	.06	.12
Minneapolis	.....	.....	1.90*l*	21.70	26.70	.098	.137	21.85	34.65	.0638	.....	.....
Montreal	85.00*	60.00	3.42	14.00	20.00	.10	.13	.0975†	.01125†	.0675	.135	.165
New Orleans	160.00	32.00	....	14.00	17.00	.065	.09	.07†	.10†	.....	.078	.11
New York	138.143§	65.00	2.80	17.00	22.00	.075	.10	.09†	.125†	.....	.075	.11
Philadelphia	120.00	45.00	....	15.00	20.00	.06	.085	.065†	.095†	.055	.07	.10
Pittsburgh	115.00	40.00	....	19.00	24.00	.077	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115.120	37.00	....	19.00	24.00	.075	.11	.08†	.115†	.0475	.09	.12
San Francisco	.....	70.00	....	12.00	18.00	12.00‡	18.00‡	12.50	23.00	.04	.0575	.117
Seattle	.....	40.00	....	25.50	25.50	17.00‡	23.00‡	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N.J., per ton, Bermudez, $25.00; Trinidad, $22.00. *Sales tax included. †Per gallon. ‡4½x6x5½ in. ‡Per ton. § 4x5x9 in. Av. & Mexican. ² Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *l* 2½ in. 6 to 8-lb. treatment. *e* F.o.b. Everett

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.40	$2.60	$3.70	$2.55	...	$42.50	$43.00	$42.00	$2.80	$3.15	$2.30	$4.35
Chicago	2.30	2.60	3.70	2.80	$2.70	42.50	43.00	42.00	2.80	3.15	2.30	4.35
Pittsburgh	2.25	2.55	3.60	2.75	2.60	42.50	43.00	42.00	2.80	3.15	2.30	4.35

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price, 15 tons or over‡: New billet	Rail steel	Add $/cwt. for Switch	Del.	EXPANDED METAL LATH Per 100 sq. yd., carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots: 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$3.65	$2.82	$2.67	.02½	.10	$21.00	$23.00	$1.75	$1.31	$0.1692	$2.60
Baltimore	3.60	2.82	2.67	...	.10	20.00	22.00	1.62	1.22	.1566	2.95
Boston	4.07	2.95	2.80	†$20 C.L.	.10	21.60d	23.60d	1.68	1.26	.1620	3.02
Chicago	2.30#	2.60	2.45	.03	.05	23.00	25.00	1.61	1.22	.1557	2.70
Cincinnati	3.95	2.815†	2.665†	...	.05	25.01	29.50	1.60	1.21	.1548	...
Cleveland	3.86	2.60	2.45	.02½	.10	21.50	23.50	1.59	1.20	.153	...
Dallas	2.45	3.335	3.185	...	...	...	...	1.86	1.38	.1791	2.85
Denver	4.48	3.43	Not stocked	...	...	22.00	25.00	1.87	1.38	.1809	...
Detroit	3.95	2.70	2.55	...	.10	22.50	24.50	1.62	1.22	.1566	2.865
Kansas City	4.24	3.02	2.87	0	.10	20.50	22.00	1.82	1.29	.1665	3.12
Los Angeles	3.825	2.95	2.80	.02½	.05	23.00	27.50	1.89	1.40	.1827	3.90
Minneapolis	4.00d	3.00	Not stocked	0	.10	26.00	30.00	1.71	1.28	.1656	3.00§
Montreal	2.90	2.40	2.40	...	...	32.50	32.50	2.46	1.82	.253	2.80
New Orleans	...	2.94	2.79	.05	.10	21.00	23.00	1.76	1.31	.1701	...
New York	3.97	2.97	2.82	...	.10	21.50	23.00	1.67	1.26	.1584	2.93
Philadelphia	3.90	2.84	2.69	...	...	22.50	24.50	1.63	1.23	.1575	2.89
Pittsburgh	2.25#	2.55	2.40	.02½	.10	20.00	22.00	1.55	1.18	.1494	2.60
St. Louis	3.99	2.82	2.67	...	.05	24.00/26.00	26.00/28.00	1.62	1.21	.1566	2.70
San Francisco	3.95	2.95	2.80	.02½	.10	24.50	26.50	1.89	1.39	.1827	3.15
Seattle	3.55	2.95	2.80	...	...	25.00	30.00	1.89	1.39	.1827	2.60

#Mill Base. ‡5–15 tons, add 15c; 1–5 tons, add 25c; less than 1 ton, add 50c. †20 tons or over Base. *d* Delivered. §Mill Price plus freight to Minneapolis.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry s	WHITE LEAD Per 100 lb. in 500-lb. lots in oil	READY-MIXED PAINT Per gal., drums: Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f. o. b. factory: Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch, 350 lb. bbl., per ton
Atlanta	$9.75	$12.375	$1.62	$3.17	$1.40	$2.68	$2.36	$2.36	$.36	$29.40
Baltimore	9.50	12.00	1.45	2.25	1.70	2.16	3.25	3.25	.40	27.00
Birmingham	9.75	12.375	2.35	2.35	1.85	2.11	1.86	1.86	.36	22.00
Boston	9.50	12.00	1.80	2.50	.0475x	1.96	2.25k	2.14k	.45	20.00
Chicago	9.50	12.00	1.80	...	...	2.48	2.37	2.37	.43	33.00
Cincinnati	9.50	12.00	1.45	2.50	1.40	2.40	2.39k	2.39k	.36	21.00
Cleveland	9.50	12.00	2.10	2.75	1.55	1.98	2.01k	2.01k	.27	25.00
Dallas	9.75	12.75	1.80	2.10	....	2.75k	2.50k	2.50k	.60	60.00
Denver	10.00	12.50	2.55	...	...	2.65	4.00	4.00	.35	30.00
Detroit	9.50	12.00	1.65	2.50	1.40	2.40	2.65	2.50	.35	30.00
Kansas City	9.50	12.125	1.83	2.79	1.21	1.93	3.15	3.15	.25	25.00
Los Angeles	9.75	12.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	9.50	12.125	....	....	....	1.85n	1.78kn	1.78kn	.29	23.80
Montreal	.....	8.20	2.00	4.75	2.40	2.50	1.60	1.83	.50	1.52§
New York	9.50	12.00	1.85	2.50	1.60	1.85	1.87k	1.87k	.033z	26.00
Philadelphia	9.50	12.00	2.515	2.94	1.515	1.95	2.86k	2.86k	.29	26.00
Pittsburgh	9.50	12.00	1.05	1.95	.80	1.95	1.94k	1.94	.34	26.00
St. Louis	9.50	12.00	1.70/1.90	2.50/2.60	1.50/1.80	1.90k	2.70	2.70	.25/.30	28.00
San Francisco	9.75	12.00	1.80	2.75	1.10–2.00	1.66	1.90	1.90	.325	20.50
Seattle	9.75	12.25	1.80	2.85	2.20	1.97	2.42	2.60	.60	28.00

*U. S. War Dept. Spec. 3–49A. †ASTM Spec. D266–31. ‡80% maximum ferric oxide. §Per 100 lb. kPer roll, 65 lb. zPer lb. nMinneapolis & vicinity

Note: Red lead in oil 50c higher than white lead in oil. # Red lead prices change frequently due to pig lead price changes.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers List, Sept. 15, 1928

	Single or Double Thickness A quality	B quality
Atlanta	85%	85%
Baltimore	88%	87%
Birmingham	88%	90%
Boston	87%	89%
Chicago	86%	87%
Cincinnati	89–10%	91–10%
Cleveland	85%	85%
Dallas	80%	80%
Denver	84%	85%
Detroit	87–10%	89–10%
Kansas City	85–10%	86–10%
Los Angeles	90%*	90–40%
Minneapolis	84–10%	85–10%
Montreal	60–30%	70–5%
New Orleans	85%	86%
New York	87%	88%
Philadelphia	88%	89%
Pittsburgh	86%	87%
St. Louis	90%	90%
San Francisco	78%	83%
Seattle	83%	86%

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal.

zAdditional delivery charge in Queens, Richmond, Kings and South of Canal St., Manhattan, $6 per trip. *c* carload lots.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases

	Gelatin 40%	60%
Atlanta	$0.15	$0.165
Baltimore	.16	.18
Birmingham	.095	.11
Boston	.16	.175
Chicago	.115c	.13 *c*
Cincinnati	.27	.29
Cleveland	.205	.21
Dallas	.16	.170
Denver	.16	.175
Detroit	.21	.24
Kansas City	.165	.18
Los Angeles	.1725†	.1925†
Minneapolis	.175	.19
Montreal	.18	.1925
New Orleans	.16	.185
New York	.23z	.245z
Philadelphia	.16	.175
Pittsburgh	.1525	.1675
St. Louis	.155	.17
San Francisco	.1475	.1625
Seattle	.1525	.1625

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York.

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00–2.85
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00–35.00
Chlorine cylinders, per lb. delivered	.055
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.60
Soda ash, 58%, in paper bags, per 100 lb. dense	1.25
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	27.00
Sulphate of copper, in bbl., per 100-lb.	5.75

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.—2 ft. from butt.	6 in.	50 to 59 ft.	.225	.24
12 in.—2 ft. from butt.	6 in.	60 to 69 ft.	.23	.255
14 in.—2 ft. from butt.	6 in.	50 to 69 ft.	.24	.265
14 in.—2 ft. from butt.	6 in.	70 to 79 ft.	.265	.275
14 in.—2 ft. from butt.	5 in.	80 to 85 ft.	.38	.415
14 in.—2 ft. from butt.	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft
Boston	Oak, untreated	$1.10	$1.50
	Pine, untreated	1.10	1.50
	Pine, creosoted	1.60	2.25
New York	Long-leaf sap pine, untreated	1.10	1.30
	Mixed oak, untreated	1.25	1.45
	White oak, untreated	.85	1.35
	White oak, creosoted	1.50	1.70
Birmingham	Southern pine, untreated *6 x 8 x 8' 6"	.55*	.70
	Southern pine, creosoted	1.10*	1.30
	White oak, untreated	1.25	1.55
Chicago	Oak, empty cell, creosoted	1.67	2.05
	Oak, zinc treated	1.55	1.90
	Southern pine, creosoted	1.50	1.95
Los Angeles	Fir, untreated	.64	1.38
	Fir, creosoted	.90	1.80
Philadelphia	Red oak, untreated	1.25	....
	Red oak, creosoted	....	2.60
	White oak, untreated	1.15	1.48
St. Louis	Red oak, untreated	1.15	1.48
	Red oak, creosoted	1.65	2.00
	Sap pine or cypress, untreated	.97	1.10
San Francisco	Douglas fir, green, untreated	1.15*	....
	Douglas fir, empty cell, creosoted	....	2.45
Montreal	Birch or maple, untreated	.65	.75
	Birch or maple, creosoted	1.05	1.35

CURRENT PRICES OF CONSTRUCTION MATERIALS

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE — Full standard weight. #			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, ASTM C 13-35 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots., f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-35 12 in.	24 in.	1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$50.00	0.26dk	$0.468dk	$1.629	$4.50k	$85.00	$128.00	$0.45	$1.625	44.5	35.5	42	32.0
Baltimore	53.50	.28	.54	2.38	7.18	110.00	170.00	.40	1.60	....	....	....	....
Birmingham	46.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	64.5	55.5	62	52.5
Boston	53.50	.224	.432	1.98	5.845	99.00	153.00	.43	2.40	....	....	....	....
Chicago	54.50	.245	.54	2.25	5.125	100.00	150.00	.38	1.48	52.5	41.25	50.625	37.5
Cincinnati	53.00	.217	.4185	1.80	5.2275	75.00	120.00	.80	2.20	52.6875	41.4375	49.5625	37.6875
Cleveland	54.50	.196	.378	1.62	4.8175	69.00	108.00	.35	1.50	56	44.5	51.5	40.5
Dallas	58.00	.40	....	....	.....	160.00	260.00	.46	1.57	69.5	61.5	67	58.5
Denver	66.00	.29‡	.50‡	2.10‡	.....	130.00	220.00	....	....	44	33	41	29
Detroit	52.40	.203	.3915	1.71	5.2375	82.00	136.00	.35	1.20	53.2	41.9	50.1	37.8
Kansas City	54.60	.30	.54	2.16	5.00	120.00	140.00	.45	1.60	49	37.6	45.8	34.
Los Angeles	54.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	57.1	48.1	54.6	44.6
Minneapolis	56.50	.24‡	.432‡	1.728‡	4.60‡	.....	.....	.65	1.75	....	....	....	....
Montreal	55.00	.33‡	.59‡	2.04‡	.....	82.00	134.00	.51	2.04	....	....	....	....
New Orleans	52.00	.26	.468	1.69	.....	.....	.....	.45	1.65	....	....	....	....
New York	53.00	.28	.58	2.45	6.30	.....	.....	.55	2.00	52.49z	41.53z	48.20z	37.80z
Philadelphia	50.00	.224	.45	2.25	6.00	150.00	180.00	.54	1.80	64.5z	55.5z	62.z	52.5z
Pittsburgh	56.00	.182‡	.351‡	1.575‡	4.92‡	97.80	154.20	.85c	2.00	64.5	55.5	62	52.5
St. Louis	47.00	.28	.504	2.016	3.96	85.00	170.00	.75	1.75	51.125	39.875	48	36.125
San Francisco	54.00	.315L	.567L	2.268L	5.67L	103.50	172.50	.45	2.50	53	44	42.75	33.33
Seattle	55.50	.420	.63†	3.06†	7.55†	85.00	200.00†	.50†	1.60	65.80	57.25	66.75	56.30

* b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $50.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional. 30 in. and larger usually $2 per ton less.

‡ f.o.b. † Less 30% in C/L Lots. d Double strength. k List to dealers. L List. t Sales & municipal taxes extra.

Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in. 11½ c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½ c.; 4 in., $1.09; 6 in., $1.92.

k 2½ to 3 in. z Resale price to consumer, car load lots shipped from mill.

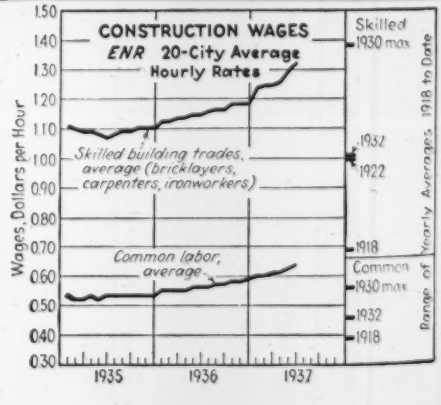
LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face). All Fir planks No. 2 common; Fir timber is No.1 common. Lengths up to 20 ft. (Prices in italics) 1x6,§	1x8,§	2x4,§	2x6,§	2x8,§	2x10,§	3x12,§	6x12,§	12x12,§	LONG LEAF Y. P. Merchantable grade up to 20 ft. 2x12,§	12x12,§	PLYWOOD Rail freight increment (See note) ¾"	¼"
Atlanta	$20.00	$20.00	$20.00	$20.00	$20.00	$22.00	$27.00	.....	.....	$47.00	$47.00	$16.80	$20.50
Baltimore	29.00	30.00	32.50	32.50	33.50	35.00	42.00	.....	.....	64.00	64.00	16.45w	20.05w
	35.00	35.00	35.50	33.50	33.50	34.00	37.00	$37.00	$35.50	.....	.....	.....	.....
Birmingham	26.00	26.00	27.00	26.00	26.50	28.00	38.00	37.00	37.00	.....	.....	15.55	18.95
[1]	28.00	28.00	32.00	30.00	33.00	35.00	54.00	.....	.....	55.00	55.00	.....	.....
Boston	35.00[2]	35.00[2]	40.00[2]	40.00[2]	55.00[1]	65.00[1]	80.00[1]	.....	.....	80.00	80.00	16.45w	20.05w
	35.00	35.00	40.00	40.00	40.00	43.00	45.00	50.00	50.00	.....	.....	.....	.....
Chicago	28.00	29.00	28.00	27.00	28.00	32.00	42.00	.....	.....	70.00	70.00	12.45	15.15
Cincinnati	25.50	25.50	25.50	24.50	24.50	28.50	39.50	.....	.....	41.00	41.00	15.55	18.95
	.....	.....	.....	.....	.....	.....	43.75	43.75	43.75	.....	.....	.....	.....
Cleveland	37.00	39.00	43.00	37.00	45.00	47.00	54.00	49.00	48.75	57.00	69.00[3]	15.55	18.95
Dallas	33.50	35.00	38.50	32.50	35.00	36.50	46.50	51.50	66.00	42.50	85.00	13.15	16.05
Denver	46.00	46.00[4]	50.00	49.00	49.00	55.00	64.00	67.50	67.50	.....	.....	9.35	11.35
Detroit	33.00	33.00	33.00	33.00	33.00	35.50	43.00	.....	.....	32.00	44.00	15.55	18.95
	.....	.....	.....	.....	.....	.....	46.50	47.50	50.00	40.00	50.00	.....	.....
Kansas City	32.00	32.00	30.00	29.00	30.00	31.00	40.00	.....	.....	56.00	62.00	11.45	13.95
	29.00	29.00	32.00	32.00	32.00	33.00	35.00	40.00	40.00	.....	.....	.....	.....
Los Angeles	36.00	35.00	36.00	35.00	37.00	37.00	41.00	48.00	43.00	.....	.....	8.90wz	10.80wz
Minneapolis	54.00[4]	54.00[4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.45	13.95
	45.00	45.00	48.00	46.00	46.00	47.00	65.00	67.50	67.00	47.00	.....	.....	.....
Montreal	46.00	48.00	52.00	50.00	54.00	69.00	84.00	.....	.....	.....	.....	.....	.....
	54.75	54.75	49.25	60.75	60.75	64.25	47.00	.....	.....	.....	.....	.....	.....
New Orleans	33.00	36.00	42.00	34.00	40.00	39.00	50.00	.....	.....	54.00	59.00	13.15	16.05
	28.95	31.50	35.90	29.50	33.00	34.00	38.00	.....	.....	.....	.....	.....	.....
New York	39.00	40.00	39.00	41.00	41.00	42.50	47.50	.....	.....	80.00	82.50	16.45w	20.05w
	.....	.....	50.00	50.00	50.00	50.00	50.00	55.00	55.00	.....	.....	.....	.....
Philadelphia	27.50	29.00	28.50	29.00	30.00	31.00	33.50	.....	.....	70.00	70.00	16.45w	20.05w
	40.00	40.00	38.25	39.00	40.00	40.00	40.00	46.50	46.50	.....	.....	.....	.....
Pittsburgh	38.10	39.90	47.05	42.00	45.65	46.90	59.70	.....	.....	57.50	57.50	16.20	19.70
	51.90	49.60	49.60	49.00	48.90	49.25	66.55	66.55	66.55	.....	.....	.....	.....
St. Louis	33.00	34.00	32.00	31.00	32.00	34.00	49.00	54.00	54.00	72.00	71.00	13.15	16.05
San Francisco	26.50	22.00	27.00	22.50	26.50	22.50	29.00	22.00	22.00	.....	.....	6.95w	8.50w
Seattle	17.50	17.50	17.50	16.50	16.50	16.50	22.00	21.00	21.00	.....	.....	0.00	0.00

§ S4S. ‡ Rough. * All prices delivered. † Yard prices. ‡ Contractors in Minneapolis & St. Paul get 10% disc. from list. § 5M ft. or less s At ship's tackle. d 10% Disc. taken off. [1] Long leaf. [2] Roofers N.C. Pine. [3] Spruce [4] Native. [5] Western Pine. [7] Pine. [8] Norway Pine. Bold face type, Southern Pine. Italics, Douglas Fir.

Note: Special concrete form grade Fir Plywood, 4'x8' panels, 5-ply, sanded 2 sides, water resistant glue, car load lots, delivered per 1000 sq. ft. surface. Base price—Seattle: ⅝", $70.125; ¾", $80.025. For other centers add rail freight increment from table for proper size. Add: for form oil treatment $2.50 per M. sq.ft.; for mineral paint sealed edges, $1.00 per M; for resin dipped treatment $10.00 per M. w Lower rate by water shipment. z 50,000 lb. minimum.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor — Building	Common Labor — Heavy Const.
Atlanta	$1.25	$0.40/1.00	$1.00/1.25	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.25	1.25	1.375	1.50	1.25	.45	.45
Birmingham	1.50	1.00	1.25	1.125	1.00	.30/.40†	.30/.40†
Boston	1.50	.90/1.375	1.375	1.00/1.375	1.625	.60/.80	.60/.85
Chicago	1.70	1.625	1.50	1.50	1.70	1.025	1.025
Cincinnati	1.00/1.625	.70/1.35	1.40	1.00/1.40	1.00/1.625	.60	.60
Cleveland	1.625	1.375	1.50	1.375	1.50	.90	.90
Dallas	1.25	1.00	1.00	1.00	1.25	.40	.40
Denver	1.50	1.50	1.43	.....	1.43	.714	.714
Detroit	1.50	1.25	1.25	1.25	1.55	.60/.80	.60/.80
Kansas City	1.50	1.25	1.25	1.25	1.45	.80	.45/.50
Los Angeles	1.10	1.10	1.125	1.125	1.25	.60	.60
Minneapolis	1.375	1.25	1.25	1.25	1.50	.75	.75
New Orleans	1.00	.75/1.00	1.00/1.25	1.00	1.00	.30/.40	.30/.40
New York	1.886	1.75	1.65	1.50/1.65	2.00	.825	.60/.85
Philadelphia	1.50	1.00	1.375	1.50	1.375	.40/.50	.40/.50
Pittsburgh	1.50	1.25	1.375	1.00	1.50	.70	.50
St. Louis	1.50	1.25	1.75	1.57/1.75	1.50	.875	.45/.875
San Francisco	1.50	1.125	1.375	1.125	1.50	.75	.60
Seattle	1.50	1.335	1.375	1.375	1.50	.90	.90
Montreal	.70	.60	.65	.55	.70	.40	.35

Skilled Avg.: (Bricklayers, Carpenters, Ironworkers) $1.327; Common Avg. $0.640. † PWA.